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**Action Research to Promote Tsunami Risk Reduction:
Ethnographic Approaches to Disaster Education and
Tsunami Evacuation**

by
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A thesis submitted in partial fulfillment of the requirements
for the Degree of
Doctor of Philosophy in Informatics

Supervised by
Prof. Katsuya Yamori

**DEPARTMENT OF SOCIAL INFORMATICS
GRADUATE SCHOOL OF INFORMATICS**



**Kyoto University
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Acknowledgements

I have been frequently asked by disaster researchers about one question, “If people decided not to evacuate when tsunami comes, why do you insist them evacuating?” This is very similar to some controversial questions in other research areas. In pedagogy, there is a typical question stated as “If children decided not to go to school, why do you insist them going to?” In medicine, a serious problem represented as “If patients decided not to receive treatment, why do you insist them receiving it?” These questions are intertwined with research ethics, and could develop into complicated problems according to the researchers’ correspondence.

In the field of tsunami risk reduction, to help people who reject evacuation, it is important for researchers to understand the considerations of those people. Then, with more critics and respects to those people, researchers could find an effective way about how to communicate with them. During these processes, there is a possibility for both researchers and the people to change their mind toward tsunami evacuation. However, the fact is that, researchers usually cannot get access to the people who have such consideration. In other words, voices of those people are always represented by scientific neutral data or predicted outcomes, though there should be more factors exerting influence on a person’s mind.

People who taught me about the significance of individual situations were local residents in Okitsu village, Shimanto town of Kochi prefecture. I want to thank all the people in Okitsu, school students and residents, who have made this work possible: in particular, I thank the schoolteachers, community leaders, participants of single-person drills and their family members. During my ethnographic study, I sometimes even have been reminded by other researchers that I seemed to be an Okitsu resident. I will never forget lovely smiles on residents’ faces when I arrived at Okitsu every time. I even doubt about whether I can make contributions to my research field, because most of the activities were actually planned and conducted by residents themselves. I was the real beneficiary who received all the achievements of collaborative activities. Therefore, I sincerely understood the essential meaning of “research in action,” not “action in research.”

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Abstract

This thesis investigates the process and configuration of tsunami risk reduction through action research. Also discussed are an overview of the theory of communities of practice, and the possibility of application of the research methodology. Instead of observing the research subjects from the viewpoint of an external observer, I perform as an engaged participant in the action research. I intend to achieve better conditions for local communities with collaborations of research subjects.

Regarding the tremendous damage caused by the Great East Japan Earthquake, central and local government agencies reappraised and published a series of tsunami predictions of a megathrust earthquake in the Nankai trough. The tsunami predictions made profound impacts on community residents and therefore three types of negative attitudes toward tsunami risk reduction emerged: overly pessimistic, overly optimistic, and overly dependent.

To find appropriate approaches to these negative attitudes, I have conducted ethnographic studies of tsunami risk reduction in Okitsu village, Shimanto town in Kochi prefecture over the last three years. Except for introducing knowledge and skills of tsunami evacuation, I suggest a new approach called “single-person drill.” During a single-person drill, a single evacuee, typically an elderly person with a piece of GPS device heads from home to a designated evacuation shelter. A group of school students record the drill process as a lesson regarding disaster education. All the records of the drill are summarized into multi-screen movies. In the movies, disaster risk communication is represented by two kinds of message: messages from the evacuee and messages from the students. Tsunami movement and human behavior are displayed in synchronization on a GIS map. In this way, the survivability of each evacuee can be seen easily. In addition, not only disaster experts, but also community residents make significant contribution to the production of those movies.

The single-person drill shifts community level artefacts such as evacuation shelters to individual level ones. When a resident actually climbs up to an evacuation shelter, the existential meaning of the shelter is changed in the resident’s mind from that of a simple physical artefact to one of vital existence. The drill provides a good chance for school students to participate in and support residents’ evacuation by actually managing the process to further their disaster education. It gradually transformed residents who had negative attitudes into those who take initiative in reducing risk. Disaster experts also recast themselves who just calculate neutral “danger,” to partners who collaborate with community residents by sharing “risk.”

In this way, this thesis describes how to implement tsunami risk reduction through collaborative practice between researchers and residents. It applies the framework of communities of practice to make theoretical consideration to the whole process of the action research, and furthermore derives implications for community-based disaster prevention activity.

要旨

本研究は、南海トラフの巨大地震・津波による被害が想定されている高知県四万十町興津地区でのフィールドワークを通して、地元の学校、住民、自治体など、多様な関係者によって推進されている津波防災の実践について、その構図とプロセスを記述し分析するとともに、今後について展望したアクションリサーチである。同時に、本論文では、同実践を実践共同体論の視点から理論的に位置づけるとともに、少数の事例に依拠したエスノグラフィックな研究の方法論的位置づけについても考察を展開している。

本研究は、主として、2つの問題系に着目して考察が進められている。

第1に、津波防災をいかに推進するかという実践的な問題系であり、具体的な課題としては、学校における防災教育と地域における避難訓練の取り組みがとりあげられている。本論文では、従来型の避難訓練に代わる新たな手法として「個別避難訓練」と呼ばれる取り組みが提案され検証される。個別避難訓練とは、個人または家族が、普段いる場所から高台など自分たちが逃げようと思う避難場所まで、避難経路を記録するGPSロガーを装着して実際に逃げてみる訓練である。この一部始終を、地元小学校の児童がビデオカメラで撮影し、所要時間を計りながら避難状況について記録する。

以上の結果は、動画カルテと呼ぶ画面の映像に集約される。動画カルテは、避難場面を映したカメラ映像、訓練参加者の訓練中の発話と児童から訓練者へのメッセージ、GPSロガーの記録を映し出した地図から構成されている。地図には、訓練者の現在位置、そこへと至る移動経路が示され、その上に津波浸水シミュレーションが重ねられている。個別避難訓練は、動画カルテというアーティファクトを中核にした多様な関係者の共同実践を通して、防災に関心の低い人を動機づけることを意図した実践である。

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たとえば、個別避難訓練における児童の訓練支援の枠組は、支援すること自体が防災学習にもなるからである。これによって、それまで地域の防災実践に関与できなかった児童らは、学習者であると同時に、地域防災の実践を担う存在へと変化する。住民側にも、児童らに支援されることを通して、「わたしこそが訓練の主役だ」、「わたしを心配してくれている人がいる」との意識が芽生える。一方、行政や専門家も、個々の住民の訓練支援に関与することを通して、単なる外在的支援者ではなく、「地域住民と共にコトをなす人」へとアイデンティティを再構築する。

このように、本研究は、具体的な地域社会において津波防災を推進するとともに、それをめぐるアクションリサーチのプロセス全体を実践共同体論の視点から位置づけ、それに立脚した将来展望が提示している。

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Chapter 1

Introduction

1.1 Research objectives

This thesis investigates the process and configuration of tsunami risk reduction through action research in a remote mountainous coastal community expected to be hit by a large-scale tsunami in the event of a megathrust earthquake in the Nankai trough, south of the Japanese mainland. Also discussed are an overview of the theory of communities of practice (Lave and Wenger 1991; Wenger 1990, 1998), and the possibility of application of its research methodology.

I argue that promoting tsunami risk reduction requires collaborative practice among various participants. Among them, the community residents—who will be evacuees should a tsunami come—are expected to take a leading role in tsunami risk reduction. Disaster experts and government agencies are expected to give intellectual or physical support, rather than instructions to community residents. Here the collaborative practice conducted by community residents, disaster experts, and government agencies is designated as a community of practice.

Coping with tsunami risk requires that community residents actively take part in tsunami disaster prevention activities. It is also important for community residents to collaborate with disaster experts and government agencies, because activities conducted by community residents without professional support will likely have poor outcomes in an actual disaster (Ushiyama 2008).

In this thesis, I consider how to evaluate tsunami risk reduction activities conducted mainly by community residents, whether such activities enhance disaster resilience in those communities, and what should be done to avert damage due to a future Nankai megathrust earthquake. On the basis of this discussion, I suggest disaster mitigation measures for a Nankai megathrust earthquake in particular.

The thesis focuses on two topics. The first is identification of subjects for investigation and practice, focusing on issues related to tsunami evacuation and disaster education. Both have developed many traditional approaches to tsunami risk reduction, the effectiveness of which were broadly confirmed during the Great East Japan Earthquake of 11 March 2011. A new approach called the “single-person drill” that merges the essential elements of tsunami evacuation and disaster education provides a primary example for investigation.

The second topic regards the direction of theoretical considerations, applying the theory of communities of practice to discuss the process and the configuration of tsunami risk reduction. Three dimensions extracted from the communities of practice are that participants share “the mutual engagement, a joint enterprise, and a shared repertoire”

(Wenger 1990:73). Activities for tsunami risk reduction exhibit such features, in that they share a goal of motivating timely evacuation to safe places.

This study is an action research conducted in Okitsu village of Shimanto town in Kochi prefecture, Japan. This thesis comprises six chapters. Chapter 1 gives the fundamental background of the research. Chapter 2 describes the historical development of disaster education in Okitsu. Chapter 3 investigates the consciousness of tsunami risk and tsunami evacuation through a questionnaire survey conducted in Okitsu. Chapters 4 and 5 describe the implementing process and results of the single-person drill conducted with community residents in Okitsu. These chapters discuss in detail the motivation for participation by community residents, the relationships among participants, and the identity transformations of participants.

Applied methodologies are based on the mainstream methods of ethnographic studies, such as data analysis, participant observation, semi-structured interviews, and questionnaire surveys. Through discussions of the microscopic structure of local activities, this study elucidates the macroscopic configuration of practice and studies of tsunami risk reduction.

The principal subjects and the fundamental problem consciousness of this research are presented as follows. Section 1.2 summarizes the texts and subtexts of this study, in particular the reasons why tsunami risk reduction is important. Subsection 1.2.2 analyses the importance of tsunami evacuation in tsunami risk reduction. Subsection 1.2.3 shows the necessity of promoting disaster education for tsunami risk reduction. Subsection 1.2.4 summarizes the features of the research field from the perspective of tsunami risk reduction. Section 1.3 presents the theoretical premise and research stance of this study. Subsection 1.3.1 presents an overview of the theory of communities of practice, and 1.3.2 expresses the fundamental research stance. Finally, Section 1.4 describes the chapter arrangement of this thesis in detail.

1.2 Texts and subtexts

This thesis discusses the significance of tsunami risk reduction to suggest new measures for coping with an expected future Nankai megathrust earthquake. After the Great East Japan Earthquake, the importance of tsunami risk reduction—especially tsunami evacuation and disaster education—has been widely realized by stakeholders such as communities, schools, municipalities, disaster experts, non-profit organizations, and private corporations.

1.2.1 Tsunami risk reduction

The Great East Japan Earthquake measured 9.0 on the Richter scale and had a maximum seismic intensity of 7, making it the largest earthquake to hit Japan in recorded history. It originated in the Pacific Ocean east of Miyagi prefecture at 14:46 JST on 11 March 2011. The hypocentre was very wide, ranging from offshore Iwate prefecture to offshore Ibaraki prefecture. The earthquake generated a huge tsunami with wave height exceeding 10 m in some areas, and a maximum run-up height exceeding 40 m (Japan

Meteorological Agency 2011a). The tsunami caused catastrophic damage to the Tohoku region and part of the Kanto region. The Tokyo Electric Power Company's Fukushima Daiichi nuclear power plant was crippled by tsunami over 15 m, because the reactors were designed to withstand waves only up to 5.7 m (Tokyo Electric Power Company 2011). This disabled emergency generators required to cool the reactors, resulting in radiation release that transformed a tsunami disaster into a serious nuclear disaster.

Averting damage from the ensuing tsunami was clearly the greatest challenge to disaster prevention posed by the Great East Japan Earthquake. In this section, I discuss the urgency of tsunami risk reduction through three main results of the Great East Japan Earthquake: damage to property and human suffering, shortcomings of tsunami evacuation shelters revealed by the disaster, and reappraisals of the potential for tsunami related damage.

Tremendous damage

The Great East Japan Earthquake and the resulting tsunami caused widespread destruction. According to the report of Central Disaster Prevention Council (CDPC Report) (2011a), the National Police Agency (2014), and the Reconstruction Agency (2014), current records list 15,885 fatalities, and 2,623 persons still missing. 263,392 persons are living in refuge facilities as of this writing. The total area inundated by the tsunami exceeded 560 km², which is comparable to the area of central Tokyo (621 km²). 127,305 houses were completely destroyed, and 272,941 were partially destroyed.

The Reconstruction Agency (2011) estimated 16.9 trillion yen in direct financial damage, and that over 23 trillion yen would be needed for reconstruction over the next decade. The tsunami caused Japan and the international society to reflect on what tsunami risk reduction measures should be taken to protect lives and property from future disasters. This is an urgent issue in Japan's Eastern coastal regions, where the likelihood of a catastrophic Nankai megathrust earthquake occurring within the next 30 years is estimated as 70% (Headquarters for Earthquake Research Promotion 2013).

Shortcomings of shelters

The Great East Japan Earthquake was described as an unprecedented, unimaginable disaster because it exceeded all tsunami estimates and hugely impacted the whole society. The CDPC Report (2011b) delivered the following assessment: "A review of coastal protection infrastructure shows that although it proved effective up to the tsunami height for which it was designed, the recent massive tsunami and subsequent devastation underscored the shortcomings of disaster prevention measures that were overly dependent on this infrastructure." Infrastructure such as sea levees was thus insufficient to prevent the destructive tsunami from reaching people's homes.

Shortcomings of tsunami evacuation shelters have been largely reported by both national and local newspapers. Jiji Press (2012) reported that 16% of the 2,032 tsunami evacuation shelters in the Tohoku region were inundated. According to a survey by Kahoku Shimpō (2011), 48 of the 411 designated tsunami evacuation shelters in coastal Iwate prefecture were inundated. Nearly half of the designated shelters in Rikuzentakada were

destroyed, and there were many fatalities among those who had evacuated to shelters. Sankei Shimbun (2011) reported that approximately 65% of the 1032 fatalities among Kamaishi citizens occurred in regions designated as safe from tsunami, according to hazard maps distributed by the local government in 2005.

Such shortcomings of tsunami evacuation shelters forced central and local governments to review their disaster prevention infrastructure. The governor of Kochi prefecture commented, “We have done our best, based on previous worst-case predictions. Nonetheless, the tragedy of the Great East Japan Earthquake was a valuable lesson regarding the urgency of re-evaluating our tsunami disaster prevention measures” (Asahi Shimbun 2011).

Tsunami estimate reappraisals

Prompted by the Great East Japan Earthquake, the Cabinet Office of Japan immediately organized several institutions specifically to discuss appropriate countermeasures for a Nankai megathrust earthquake. In March and August 2012, the first and second reports regarding seismic intensity distribution and tsunami information of a Nankai megathrust earthquake were published. In August 2012 and March 2013, the first and second reports regarding estimates of damage from a Nankai megathrust earthquake were published in succession. These reports present worst-case scenarios of inundated areas totalling 1,015 km², 1.8 times larger than those in the Great East Japan Earthquake. They predict that 124 municipalities would be inundated by a five-meter tsunami, and an additional 23 municipalities would be inundated by a ten-meter tsunami. The highest projected tsunami could reach 34 m, and up to 323,000 fatalities are possible (Cabinet Office 2012a, 2012b, 2012c).

From these reappraised tsunami predictions, local municipalities expected to be influenced by a tsunami started to re-evaluate their tsunami risk reduction measures. For example, because the effectiveness of designated shelters was questioned, some shelters lost their designation as new ones replaced them. Kochi prefecture, where a highest tsunami of 34 m is estimated, quickly organized the Division to Discuss Measures for a Nankai megathrust earthquake to support rapid reappraisal of tsunami and resulting damage estimates, and to reformulate tsunami risk reduction countermeasures (Asahi Shimbun 2011).

1.2.2 Tsunami evacuation

Tsunami evacuation is an obvious pre-impact way of mitigating adverse outcomes by preserving life, reducing injuries, and protecting some personal property that can be easily carried. To prepare for the potential damage of a massive tsunami following a Nankai megathrust earthquake, tsunami evacuation is an important issue for tsunami risk reduction. This section explains the importance and necessity of tsunami evacuation in two dimensions: the results of evacuation behaviors in the Great East Japan Earthquake, and academic studies of tsunami evacuation.

Tsunami evacuation behaviors

Numerous large-scale surveys and individual case studies have shown that evacuation methods are vital to survival. Examples of large-scale survey data are the CDPC Report (2011c), surveys by Ministry of Land, Infrastructure, Transport and Tourism (2011), Survey Research Centre (2011), and Weathernews Inc. (2011). Individual case studies can be seen in Bungeishunju (2011), Information Support pro bono Platform (2012), Murai (2011), and Sanriku Shimpocha (2011). From these reports, four serious problems in tsunami evacuation are indicated.

One problem is delayed evacuation. According to the Japan Meteorological Agency (2011b), even in some coastal regions known to be at high risk of tsunami incursion, residents had more than ten minutes to evacuate before flooding began. Residents of southern Miyagi prefecture had almost an hour to evacuate. However, a survey conducted by Weathernews Inc. (2011) that asked respondents about themselves and about friends or family members who died indicated that approximately 77% of fatalities were among those who did not evacuate immediately after the earthquake.

A second problem is the high failure rate of evacuation by the elderly. Ushiyama and Yokomaku (2012) reported that 64% of victims were over 60 years old, and 46% were over 70. These results are similar to other recent disasters. For example, in the 1995 Great Hanshin–Awaji Earthquake, respective figures for the same categories were 58% and 39% (Hyogo Prefecture 2005a). Among the 387 fatalities in heavy rain disasters in Japan from 2004 to 2010, the corresponding figures were 65% and 49% (Ushiyama, Takayanagi, and Yokomaku 2011).

A third problem is casualties among local volunteer firefighters¹⁻¹. According to Fire and Disaster Management Agency (2012), among 254 casualties of local volunteer firefighters, 78% died while trying to evacuate other people. One surviving firefighter said, “They knew the tsunami was coming, but could not bring themselves to evacuate while others remained behind.” This result gave a hard hit to the traditional cultural importance of *kyojo* (“mutual help”) in Japanese society, because local volunteer firefighters have been anticipated providing mutual help under emergency conditions since the Great Hanshin–Awaji Earthquake.

A fourth problem is use of vehicles for evacuation. According to the CDPC Report (2012), approximately 56% of evacuees used vehicles for evacuation, but more than one-third were caught in traffic jams. Those who used vehicles for evacuation also encountered other problems, such as damaged roads and inoperative traffic signals. Indeed, many victims were found drowned in their cars. This indicates that while the importance of walking or running to shelters has long been held as a principle of tsunami evacuation, such rules were not adhered to under emergency conditions.

The Great East Japan Earthquake highlighted the importance of motivating individuals’ tsunami evacuation, and the necessity of transferring tsunami risk reduction from the community level to the individual level. This is problematic, however, given Japan’s extremely high rate of 25% elderly population.

Tsunami evacuation studies

Let us begin with a brief introduction to previous studies on general evacuation behaviors. Quarantelli (1980) pointed out that although evacuation from flooding has been an important issue since the fifth century B. C., when Egyptians living alongside the Nile River developed the custom of leaving during seasonal flooding, it did not become a major research concern until the 1970s. Quarantelli gave a general definition of evacuation as having three features: “The behavior is complex, rather than simple, interactive rather than individualistic and develops along multiple lines rather than a single path.” This suggests that the evacuation process can be seen as involving sets of behaviors by individuals and groups interacting to cope with environmental stresses rather than just reactive flight in the face of danger.

Since the 1970s, evacuation studies have flourished in various disciplines related to human behavior. In psychology, for example, most studies were conducted by experiments with research subjects in closed spaces to verify the effectiveness of various evacuation methods (Keating, Loftus, and Manber 1984; Sugiman and Misumi 1988). In science and engineering, researchers are primarily inclined to develop new models for predicting evacuation results using computer simulation system, especially geographic information systems. In these models, elements of evacuation such as the evacuation routes, shelters, warnings, or the risk of tsunami are set as exogenous parameters. Meanwhile, knowledge of the evacuation, acquisition of information, or the decision-making structure of the evacuees is set as endogenous parameters. This allows estimation of the results of a given tsunami, such as number of fatalities or how traffic jams will occur (e.g. Imamura, Suzuki, and Taniguchi 2001; Kuwasawa, Kanai, Hosoi, and Katada 2006; Takasao, Shiiba, and Hori 1995).

On one hand, agent generated tsunami evacuation simulations are very complex, due to the rarity of tsunami. In some ways they share characteristics with general evacuation behaviors, because evacuations are essentially interactions between individuals and groups (Quarantelli 1980). On the other hand, tsunami evacuations are expected, and can only be carried out by individuals reacting to tsunami flooding. Studies of tsunami evacuation can thus be summarized into two groups: one is regarding either the importance of individuals or groups, and the other is regarding either the importance of applying methods from natural science or social science.

In early studies of tsunami evacuation, researchers usually focused on group behaviors. For example, Hayakawa and Imamura (2002) developed a model to estimate tsunami evacuation ratios and evacuation departure times by considering averaging functions of information distribution systems, and translating related elements into objective parameters. Katada and Kuwasawa (2006) developed a comprehensive simulator of tsunami evacuation that combined communication, evacuation behavior, and tsunami flooding simulations to estimate casualties. Later studies of tsunami evacuation considered individual elements such as personal decision-making. Representative models of evacuation simulations involve parameters of personal evacuation route selection, means of evacuation, or evacuation shelters. Such studies can be seen in Imamura *et al.* (2001), and Shimada, Murakami, Kozuki, Sugimoto, and Nishikawa (1999). Models that consider

the ability of evacuees to deal with tsunami warning information were developed by Fujioka, Ishibashi, Kaji, and Tsukagoshi (2002), and Katada, Oikawa, and Tanaka (1999). Models that include the structure of individual decision-making can be seen in Kuwasawa *et al.* (2006), and Sato, Kono, Koshimura, Yamaura, and Imamura (2008). As these studies focus on the behavior of both groups and individuals, it is useful to apply their achievements to the practice of tsunami risk reduction. In this way, the challenges for an entire community or single individual can be easily understood, aiding discussion of tsunami risk reduction measures. However, studies that consider tsunami evacuation of the elderly or handicapped remain rare.

Nowadays, issues of tsunami evacuation relate with both human behaviors in response to stress and scientific activities that calculate tsunami risk and damage, which in turn can suggest appropriate countermeasures for risk reduction. In Japan, collaboration between social science that study human evacuation behaviors and natural science that study mechanisms of tsunami occurrence are seen in Imamura *et al.* (2001), who developed a simulation model of tsunami evacuation to estimate casualties, and tested its validity using the actual results of tsunami evacuation following the 1993 Southwest Off-Hokkaido Earthquake. A later comprehensive tsunami scenario simulator developed by Katada, Kuwasawa, Kanai and Hosoi (2004), used both natural and social science methods, and applied their research results to pre-disaster education in Owase, Mie prefecture. Katada, Kanai, Hosoi and Kuwasawa (2011) further developed an advanced scenario simulator of tsunami evacuation to specifically encourage community residents to participate in activities, and to discuss countermeasures against tsunami evacuation. However, as Katada *et al.* (2011) pointed out, it is easy to give detailed suggestions to individuals in a scenario, but less so for persons with little interest in tsunami risk reduction.

From these studies we can see a common purpose, namely an effort to get “real” data regarding individual tsunami evacuation. Community residents contributing to survey data or participating in tsunami risk reduction activities have a relatively high interest in tsunami evacuation. Gaining access to those with no interest in tsunami risk reduction remains a challenge for both researchers and government agencies. Data collected for developing simulation models are furthermore usually the results of reported attitudes, which may not reflect actual behaviors in an evacuation.

Takimoto (2003) stated that to investigate the process of actual behavior and the effectiveness of an evacuation, it is better to conduct experiments with community residents under an assumed stress situation, but this is difficult in practice because there are many uncertainties and risks. Researchers are thus inclined to develop simulations to estimate the results of tsunami evacuation. Suzuki and Imamura (2005) collaborated with 21 households in a coastal Sendai community to conduct a tsunami evacuation drill. The drill process was strictly observed by researchers and the results of evacuation route selections were directly applied to simulation models. Though various elements such as differences in participant conditions were seen, the researchers only considered information regarding evacuation route selection and some demographic factors, minimally satisfying the requirements for academic study.

To cope with the threat of a Nankai megathrust earthquake, it is necessary to motivate residents to actively participate in tsunami risk reduction activities, because they will become evacuees during a tsunami disaster. It is also important to use the methods of natural science to investigate the results of personal activities and test the effectiveness of behaviors. Promoting collaboration between human behavior and the scientific studies is thus a top priority in tsunami risk reduction. In Japan, one traditional approach recognized as useful for achieving such collaboration is disaster education.

1.2.3 Disaster education

In Japan, disaster education first became a popular approach to disaster prevention in the Meiji Era, but after World War II disaster education school curricula was significantly reduced to ensure more time for academic pursuits (Shiroshita and Kawata 2007). The Great Hanshin–Awaji Earthquake renewed interest in national policies for disaster education, however, resulting in increased disaster education by schools, non-profit organizations, and communities. The Great East Japan Earthquake provided further impetus for disaster education, and renewed questioning regarding the direction such policies should take. This section discusses the challenge and the importance of disaster education from the perspectives of aiding supporters and raising survivors in a disaster.

Becoming a supporter

In the areas affected by the Great Hanshin–Awaji Earthquake, despite the efforts of public firefighters, police or the Self-defence Forces, almost 80% of those pinned under collapsed houses or furniture were rescued by family members, neighbors, or strangers (Kawata 1997). Hyogo Prefecture (2000) reported that in contrast to the slow response of government agencies, almost 137 million volunteers rushed to the affected areas and provided effective support for emergency rescue work. More than 300,000 people were forced to live in temporary shelters for a long period after the earthquake, with approximately 60% of refugees sheltered at local schools. Hiroi (1995) reported that life in such shelters was in good order, due in large part to the dedication of schoolteachers performing tasks such as cleaning and food distribution. One lesson learned from the Great Hanshin–Awaji Earthquake was the importance of maintaining balance between *jijo* (“self-reliance”), *kyojo* (“mutual help”), and *kojo* (“public assistance”). In particular, the importance of community-based *kyojo*, emphasizing mutual help between neighborhoods, was strongly reaffirmed.

In response to the Great Hanshin–Awaji Earthquake, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) organized the Research Collaborators’ Conference on Improvement of Disaster Prevention Systems of Schools, and in 1998 published a new national curriculum that emphasized the importance of disaster education. In the new curriculum, a course called “integrated study period” was established to guarantee time for independent learning. In Hyogo prefecture, for example, almost 25% of elementary schools and 30% of junior high schools used the integrated study period for disaster education in 2002 (Hyogo Prefecture 2005b), the first year when the new curriculum came into effect.

Owing to the integrated study period, disaster education was widely introduced into school courses, and various disaster education activities based on the spirit of mutual help were practiced in and out of school classes. Significant achievements toward disaster education have resulted from advanced activities such as fieldwork in local communities for disaster map-making or identification of dangerous areas. There are also examples of experiential learning, such as organizing evacuation shelters, managing community kitchens, and encouraging students to provide parents with disaster education (Katada 2012a; Suzuki 2003; Yamori, Suwa, and Funaki 2007). Various institutions such as academic organizations, private groups, and government agencies also developed many supporting projects. Such efforts have also helped establish organizations for editing disaster education textbooks and supporting schools affected by disasters (Yamori 2010a).

Of course, disaster education is also widely practiced outside of schools. The Great Hanshin–Awaji Earthquake showed that disasters have not only natural characteristics, but also a strong connection with social characteristics. In consideration, communities designed and took part in community-based disaster prevention activities such as promoting preparation of emergency kits, establishing contact methods, and predetermining methods for evacuation. Local organizations such as neighborhood associations and voluntary organizations for disaster prevention planned evacuation drills, distributed materials related to disaster prevention, and organized workshops to discuss countermeasures.

Based on these efforts, many studies of disaster education pointed out that it was not sensible to only teach people how to survive disasters, that it is also important for disaster education to help people to become supporters. Yamori *et al.* (2007) stated that the function of disaster education was to merge the survivor and the supporter into one. The purpose of disaster education is not merely assimilation of knowledge mainly produced by disaster experts, but also to encourage people to reorganize their lifestyles and the whole community's structure. For example, a schoolteacher S. Suwa, who serves as the disaster education director at Miko High School in Hyogo prefecture, states that cultivating leaders for local disaster prevention is the priority for disaster education (Suwa 2010). In addition, Miko High School is the only school in Japan that established an independent unit to study and develop advanced curricula for disaster education.

In Japan, emphasis of the importance of mutual help in disaster education can be traced back to the 1980s, when rapid economic growth came to an end. Urbanization had resulted in an eroding of traditional cultures such as the spirit of mutual help in local communities. Problems of community collapse provoked community-based activities for revitalization. Such activities attracted attention from many academic researchers, including economists, sociologists, and disaster experts. For example, Okada (1993) proposed the idea of community revitalization from the perspective of disaster prevention. Mutual help that emerged in the communities affected by the Great Hanshin–Awaji Earthquake gave citizens of modern cities a sense of nostalgia. Simultaneously, mutual help also became a great strength to motivate affected citizens to rebuild their communities.

This social movement gradually influenced disaster education policy, and fostering people to become supporters during a disaster became a priority. Watanabe (2000) suggested that instead of directly reminding people to focus on the purpose of disaster prevention, it was better to cultivate affection toward local communities. By analysing “town walking” activities conducted by collaborations of students, non-profit organizations, and local residents, he observed unexpected effects such as more frequent interaction among participants and risk communication between participants and others in the community. Atsumi (2006) pointed out that this kind of activity has a high potential to indirectly motivate interest in disaster prevention, because high concern for disaster prevention exerts a subtle but important influence on those with less concern. Enhancing risk communication between participants and other residents thus cultivates mutual help in local communities during non-disaster periods.

Becoming a survivor

The Great East Japan Earthquake challenged current education policy, because almost 90% of its 20,000 victims died in the resulting tsunami, reconfirming the importance of rapid tsunami evacuation. In particular, a traditional Sanriku regional principle of self-preservation during tsunami evacuation called “tsunami *tendenko*”¹⁻² came to the spotlight.

Elementary and junior high school students in Kamaishi had a near 100% successful tsunami evacuation rate, a feat that was later called the “miracle of Kamaishi.” Tsunami expert T. Katada, a professor at Gunma University and a leader in tsunami disaster education, teaches three evacuation principles, one of which is “being an initial evacuee” (Katada 2012a). Similarly, high rates of local firefighter fatalities during the evacuation prompted some municipalities expected to be severely damaged by a Nankai megathrust earthquake to modify firefighter behavior guidelines. For example, new guidelines tell firefighters to eschew closing water gates after an earthquake, and to evacuate themselves immediately, while prompting others to evacuate where possible (Kochi Prefecture 2013).

Katada (2012b) noted the shift in disaster education policies from increasing survivors to increasing supporters following the Great Hanshin–Awaji Earthquake, but policies are shifting again, back to emphasizing the importance of survivors. This does not mean that policies have returned to what they were before the Great Hanshin–Awaji Earthquake. In that period, though the ultimate purpose of disaster education was to teach people to survive disasters, the methods of disaster education were to inculcate knowledge and skills such as how to use fire extinguishers and external defibrillators. In the new disaster education policies, the priority is to cultivate a new culture of disaster prevention. In particular, to protect survivors from suffering “survivors’ guilt,” it is necessary for individuals and communities to seriously consider appropriate countermeasures against disasters. These countermeasures might emphasize self-reliance or community-based mutual help, which should have two major functions. One is prompting individual residents to actively engage in disaster education. The other is guaranteeing that individuals know exactly how loved ones would perform under stress situations.

Of course, being a supporter and being a survivor are interwoven. The former emphasizes behavior after a disaster while the latter emphasizes behavior during a disaster, so disaster education that emphasizes behavior must consider both. This thesis gives concrete discussions of case studies of disaster education that aims at improving tsunami risk reduction. The following subsection briefly introduces the study field.

1.2.4 Ethnographic study field

Over the last three years, I have performed ethnographic studies of tsunami risk reduction in Okitsu village. Until now, I have visited Okitsu 30 times and stayed there for almost 80 days in total. Here I briefly introduce the village's geographical location, demographic composition, and estimates of disaster damage from the perspective of tsunami risk reduction in particular.

Okitsu is located in south-western Kochi prefecture. The village is connected to Kochi city by prefectural Roads No.52 and No.56. It takes about an hour and a half to drive to the city centre. Okitsu is famous for its natural scenery, and the entire village is designated as a Natural Park District by Kochi prefecture. The village's Omuro Beach is surrounded by green pine trees and white sand, and was selected by the Ministry of the Environment as one of the top hundred beaches in Japan. Every year, more than 20,000 visitors come to Okitsu to enjoy its beautiful nature and the beach. A local magazine edited and issued by Okitsu residents in 1936 described Omuro Beach as follows: "With its green pine trees and white sand, Omuro Beach is a beautiful scenic spot, one of the ten most attractive landscapes in Tosa. Its waves move gently in both shallow and deep areas. And how clear the water is! This is a perfect place for sea bathing. In addition, many giant shellfish such as clams and razor shells breed and grow here. Cherry clams are scattered across the white sand. These fantastic features make Okitsu a recreational spot for sightseeing and fishing in all seasons" (Editorial Board of Kubokawa Town¹⁻³ History 2005).

There are three main challenges of tsunami risk reduction in the village. One is limited access to neighboring communities. Okitsu is surrounded by the sea on three sides and mountains on one. The above-mentioned Road No.52, which links Okitsu with a nearby community, is the only transportation line. Road No.52 has more than 140 curves, making it difficult to secure in heavy rains or earthquakes.

A second challenge comes from the serious impact of being hit by a tsunami. After the Great East Japan Earthquake, the tsunami estimates for Kochi prefecture were carefully reappraised. A Nankai megathrust earthquake is expected to generate a huge tsunami that will severely damage Okitsu. According to the latest reports by Kochi Prefecture (2012), an earthquake of intensity 6-upper on the Japanese Meteorological Agency scale will cause a tsunami that will flood residential areas within 15 minutes. The maximum run-up height of tsunami waves is expected to exceed 25 m.

A third challenge comes from the area's aging population. Okitsu village is made up of three small communities, Omuro, Urabun, and Gobun. There are 551 households with a

total population of 991, 48.5% over the age of 65, and 30.9% over 75. Residents under the age of 15 account for only 7.5% of the population (Shimanto Town 2013).

Compared with other areas regarding the above mentioned three challenges, Okitsu's tsunami risk reduction can be seen as one of the most difficult cases in Japan. For example, there are 20 municipalities in Kochi prefecture expected to be destroyed by a tsunami when a Nankai megathrust earthquake occurs. On average, 39.3% of residents in these municipalities are over the age of 65 (Kochi Prefecture 2014), far exceeding the 25.2% rate for the whole country. As discussed in Section 1.2.2 the elderly are more likely to become disaster casualties, so promoting tsunami risk reduction with older adults is a priority for Okitsu. Discussing tsunami evacuation measures and disaster education implemented in Okitsu provides insight for areas where the geographical or demographical conditions are better than Okitsu; by thoroughly investigating problems in Okitsu, we can obtain hints toward effective solutions for community-based tsunami risk reduction in other areas.

To fully understand the problems of tsunami risk reduction in Okitsu, and to grasp the essential meanings of community-based tsunami risk reduction, this chapter introduces communities of practice as a theoretical premise.

1.3 Theoretical premise and research stance

1.3.1 Communities of practice

The term of communities of practice was introduced by anthropologist J. Lave, and further developed by computer scientist E. Wenger. Communities of practice presents a theory of learning that assumes engagement in social practice is the fundamental process by which we learn and so become who we are (Wenger 1998). Lave and Wenger reject the traditional view of learning as arising out of mental operations for acquisition of knowledge, but locate learning in the increased access of learners to participating roles in expert performances. They propose that a community of practice is a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice (Lave and Wenger 1991). This theory has been applied to various disciplines, such as situated learning, sociology, computer science, and ethnomethodology.

For the practices of tsunami risk reduction in local communities, the first and foremost priority is to engage residents, especially those with little interest in disaster prevention, to take part in activities. This means that, through participation in tsunami risk reduction, residents are expected to change their attitudes and behaviors to enable appropriate response in an emergency situation. Because the collaborative activities of tsunami risk reduction share features described in communities of practice, it would be useful to apply the theory to activities in a local area to raise concrete discussions and to propose new countermeasures against tsunami disasters.

This section introduces three key concepts from Lave and Wenger (1991), and Wenger (1990, 1998)—artefact, practice, and identity—based on studies summarizing the theory of communities of practice.

Artefact

In an ethnographic study, Wenger (1998) presents practice and identity as two key concepts of communities of practice, to analyse the learning process in a large insurance company. He pays particular attention to artefact to discuss issues of understanding, which is one of his analytical categories. As an example he considers the work sheet as an object that causes problems for employees, and analyses the relations between the work sheet and employees from the perspective of relations between communities. However, he does not concretely discuss the production process of artefact, instead stating that “artefacts in general, are both instruments mediating productive activity and symbolic devices mediating the construction of understanding” (Wenger 1990:94). In traditional activity theories and situated learning theories, artefact is considered to be an important component in participation (Ueno and Sawyer 2006), but have seldom been theoretically analysed.

In the field of disaster prevention, Yamori (2011) argues that the value of disaster prevention tools such as evacuation manuals and hazard maps lies not in their content, but in how they were produced. In this way, I apply the concept of artefact as a key component in the theory of communities of practice to discuss the production process and function of disaster prevention tools.

Artefacts can be physical objects such as computers or tables, or symbolic ones such as Halloween or Christmas. When these symbolic objects reappear frequently or repeat over time, they gradually become stable objects that have the same functions as physical ones (Sugiman 2006a). Wenger (1990) views that physical and symbolic material such as electricity and infrared waves belong to specific sections of the culture of technology, in which technology is construed as understanding made instrumental through mediating artefacts. By focusing on the mediating function of artefacts, Lave and Wenger (1991:101-102) argue that “participation involving technology is especially significant because the artefacts used within a cultural practice carry a substantial portion of that practice’s heritage.” Even functions of the production process of artefacts have not been mentioned directly, but hints can be extracted from Lave and Wenger’s studies that, unlike the moderate characteristic of mediating, the function of producing could create new practices in a radical way.

In the field of disaster prevention, artefacts indicate infrastructure construction such as sea levees, evacuation shelters, highly earthquake-resistant buildings, and countermeasures against disaster such as hazard maps, community disaster maps, and evacuation wisdom. For example, organizations such as the Committee for Cooperation in Disaster Prevention, whose objective is to make policies to protect citizens’ lives and properties, can be viewed as artefacts. Traditional wisdom regarding tsunami evacuation such as the tsunami *tendenko* can be classified as an artefact as well. Not only the organizations and wisdom that function to initiate human behavior, but also their tremendous influ-

ence on disaster prevention even exceeds physical artefacts. In disaster prevention activities, concepts such as “We have to inform the Committee for Cooperation in Disaster Prevention before implementing an evacuation drill” or “We have to evacuate quickly according to tsunami *tendenko*” indicate that organizations and wisdom, while not tangible, have the same character as physical artefacts. Meanwhile, the production process of artefacts in disaster prevention is strongly linked with the characteristics of countermeasures against disaster. For example, if disaster experts take a leading role in establishing those artefacts, a disposition to depend on them could be necessarily formulated among community residents. This has been confirmed by many studies (e.g., Sun, Yamori, Tanisawa, and Kondo 2013; Yamori 2013).

Practice

Wenger (1998) views practice as “the source of coherence of a community,” and introduces three dimensions of this relationship between practice and community: the mutual engagement of participants, the negotiation of a joint enterprise, and the development of a shared repertoire. Because its constituent terms specify each other in this way, Wenger argues that the community of practice should be viewed as a unit.

Based on his ethnographic study of claims processors in an insurance company, Wenger (1998) states that a practice is what claims processors have developed to do their job and have a satisfying experience at work. The critical point that makes them a community of practice is that they share a way of going about doing some things and that they share it because they have come in contact with each other, either directly or indirectly, through physical co-presence or through some other way.

In the field of disaster prevention, a practice can be seen as efforts made by disaster experts to promote resilience of local communities against disaster. Similarly, practitioners in local communities taking part in the activities of community kitchens to prepare for refugee life can also be seen as a practice. From the same point of view, when community residents collaborate with local government agencies to discuss the construction of new evacuation shelters or proposals to fix furniture inside their houses, this too be seen as a community of practice. The activities of family members talking about tsunami evacuation plans and deciding whether to follow tsunami *tendenko* are absolutely communities of practice. Compared with similar concepts such as *habitus*¹⁻⁴ and institutions, the most crucial characteristic of communities of practice is a “shared practice” (Wenger 1990:148), which indicates co-participation in practice, or practical co-engagement.

Wenger (1990) argues that the existence of communities of practice over time is driven by the persistence of the need fulfilled by the practice, as perceived by its practitioners. This persistence over time implies processes of reproduction at two levels in communities of practice. The two levels are reproduction of the practice, and reproduction of the membership. In this subsection, I discuss the former reproduction. The latter will be discussed in the next subsection.

Change is an inherent characteristic of the practice of a community, no matter how routine. Simultaneously, the community organizes itself for stability in the midst of change by creating ways to deal with change and reconstitute its practice under new circumstances. The interaction of stability and change are essential elements of the evolving configuration of the entire community. For a job like claim processing, which is relatively narrow, the configuration is actually rather complex, involving for example claim technicians, the medical establishment, system designers, and a managerial structure (Wenger 1990). Thus, the practice is reproduced in and with the world by a community as a total configuration.

For disaster prevention in a local community, the concept of configuration is necessarily connected with the natural environment and human activities, thus providing good linkage with artefact and practice in the field of disaster prevention. When community residents take part in a tsunami evacuation drill by using artefacts such as emergency kits, or climbing up to artefacts such as evacuation shelters, the community of practice is maintained and renewed. Practitioners include those planning the drill, those taking part in the drill, and even those participating in the drill despite having little interest in disaster prevention.

Interaction between stability and change are ingrained in the small improvisations required for the stability of every completed activity, and in every conversation between community residents and disaster experts. For example, before the Great East Japan Earthquake local volunteer firefighters served as an important role in community-based mutual help. They were expected to help the elderly and the handicapped to evacuate, and were asked to close water gates after an earthquake to give evacuees more time to escape. But now, although local volunteer firefighters still perform important roles in community-based disaster prevention activities, their duties during a tsunami evacuation have been modified. Accordingly, the configuration of tsunami evacuation methods, which were planned by relying on mutual help have been modified. Because configurations of participation are sources of stability and change, communities of tsunami evacuation practice are thus reproduced.

Identity

Regarding the memberships among participants, Wenger (1998) points out that developing a practice requires formation of a community whose members can engage with one another and acknowledge each other as participants. As a consequence, practice entails how to become a person in that context. In this sense, the formation of a community of practice is also the formation of identities of participants. Compared with self-images and narratives of the self as constitutive of identity, Wenger goes on to state that identity in practice is defined socially, not merely because it is reified in a social discourse of the self and of social categories, but also because it is produced as a lived experience of participation in specific communities.

In the field of disaster prevention, when the Committee for Cooperation in Disaster Prevention plans tsunami evacuation drills, various practitioners are expected to be involved. Examples include workers who constructing evacuation shelters, community

leaders implementing the drill, and participating community residents. These practitioners can be seen as members that belong to the community of tsunami evacuation practice. Through the practice, new problems or new evacuation methods are likely found. For example, an evacuation route to a shelter may be found to be too steep for elderly persons. People who have never participated in drills may join other family members and enjoy the drill very much. Thus, identities of these practitioners are transformed because of the newly created relationship with artefacts and other members. This can also be explained as that "Communities of practice are organized around a practice, they have to organize themselves in such a way that their members can proceed with that practice, and proceeding with the practice both requires and results in an existentially coherent form of membership" (Wenger 1990:152).

I have mentioned that the reproduction of membership is an essential element of reproducing communities of practice. As newcomers are induced into communities of practice, their reproduction generates a contradiction in the role of old-timers because the continuity of the practice entails displacement of the old-timers. That is to say, the contradiction between continuity and displacement is fundamental to the social relations of production and to the social reproduction of labour (Lave and Wenger 1991).

However, among claims processors in Wenger's ethnographic study, there is little observable continuity/displacement conflict. He explains that this is because identities of mastery are not significantly commoditized. They are not commoditized as abilities to reap coveted rewards or compete for scarce resources since advancement is not selective up to higher level. In contrast, these conflicts are prevalent at the management level where identities are commoditized as instruments of power. In addition, compared to management level, the turnover rate of claims processors is very high, due to stress caused by the pressure to produce, which develops into a serious problem for the company.

Similar to the reproduction of membership of claims processors, there is little continuity/displacement conflict among community practitioners in disaster prevention. Not only are identities of mastery not related with commoditization, but also they are seldom even considered from the perspective of mastery. During the development of disaster prevention, mastery is definitely placed on the so called professionals such as disaster experts, government agencies, and community leaders, which subsequently formed a serious problem of dependency. Many residents become reluctant to take part in disaster prevention. Unlike the high rate of bound-outward problems in the insurance company, there are low rates of bound-inward problems in disaster prevention.

Though Wenger analyses the reproduction of identities in great detail from the perspective of learning in existing communities of practice, he does not extend the discussion to address what kind of motivation influences newcomers to join the practice of old-timers in a certain activity. One reason for this is because his ethnographic study confines the scope of his discussion. However, as mentioned regarding the field of disaster prevention, the first and foremost priority is to engage residents, especially those with little interest in disaster prevention, to take part in activities. In this thesis I therefore discuss

the motivation of newcomers, in particular community residents recognized as requiring assistance during a disaster, through ethnographic studies of tsunami risk reduction.

1.3.2 Research stance

Ethnographic studies in this research are conducted based on a research stance called action research. Sugiman (2006a) pointed out that all the academic studies can be divided into two types according to the relationship between the researcher and the research subject. In the natural sciences, the researcher observes the research subject from an outside place as an external observer. These studies are fundamentally conducted based on a meta-theory called logical positivism that requires newly discovered knowledge to be translated into objective language and continuously pursuing more accurate description of the research subject. In these studies, a clear boundary separates the researcher and the research subject, and the researcher should avoid posing any influence on the research subject.

The other approach is mainly seen in human sciences, in which the researcher collaborates with the research subject as an engaged participant. These studies are fundamentally conducted based on a meta-theory called social constructionism. The knowledge produced by these studies does not have universal character. The researcher is inevitably involved in a dynamic situation formed by the research subject and surrounding conditions. In other words, the researcher has no priority over the research subject. In these studies, the researcher and the research subject usually take part in a collaborative action-oriented research.

Action research provides a unique stance for human science research. It is a kind of attitude or approach applied by the researcher, or a kind of relationship between the researcher and the research subject (Yamori 2010b). There are strict fundamental standards about whether action research is needed in a given research, because researchers have to reflexively think about the value of their studies regarding the requirement from practice (Sugiman 2006b). Yamori (2010b) proposed that two standards have to be met before doing action research. One is that the social situation has significantly changed during the process of trying to improve a social situation. The other is that collaborative action-oriented research is required by both researcher and research subject who share the same concern for achieving that better social situation.

Modern social diversification has increased opportunities for action research. From the same point of view, as the whole circumstance of disaster prevention has changed dramatically, action research is needed in this study area. In Japanese society, before the occurrence of the Great Hanshin–Awaji Earthquake, disaster prevention was most thoroughly conducted by government agencies and disaster experts majoring in engineering. Within a certain amount of budget, government agencies made plans for infrastructure construction against disasters, and tried to balance budget distributions as fairly as possible between municipalities. However, after the Great Hanshin–Awaji Earthquake, differing opinions among community residents and situations among communities emerged. Diversification of the social situation makes it impossible to leave disaster prevention tasks only to government agencies. Simultaneously, because collaborative

activities are required, disaster experts also have to reconsider their relation with research subject. That is to say, action research is needed in both the practice and the study of disaster prevention.

Yamori (2013) points out that the ultimate goal of action research in disaster prevention is to achieve a unique consensus among social members. Namely, that the unexpected, potential damage from a natural disaster can be accepted and be shared by all social members. This viewpoint has roots in the argument of “risk” and “danger” proposed by the German sociologist N. Luhmann (2005). Luhmann argues that risk refers to potential future loss as a consequence of a decision. He suggests that decision-making is an essential semantic component of risk, because we can speak of risk only if we can identify a decision without which the loss could not have occurred. Furthermore, this element of decision-making distinguishes risk from danger. Danger is not conceived to be the result of a decision, but rather as a potential loss resulting from something external to the one affected. In this sense, Yamori (2013) suggests that the practice and the study of disaster prevention are eventually aiming to transform danger into risk. In other words, disaster prevention efforts attempt to transform stagnated destiny into decision-making. Therefore, in the field of disaster prevention, action research should promote decision-making activity, and make continuous movement between decision-making and destiny. This is the essential meaning of “achieving a unique consensus” (Yamori 2013:191).

This thesis reports on long-term action research conducted in Okitsu village. Practitioners in the action research are the author, other researchers, and community residents who perform as co-researchers. In other words, researchers are active participants among co-researchers.

1.4 Organization of this thesis

During the ethnographic study, I collected various materials such as written and visual records that relate to disaster prevention, especially tsunami risk reduction. Based on these results, I suggest a method to divide disaster prevention activities in Okitsu village into four periods. This is an arbitrary division to make the text less cumbersome.

The first period is before 2004, and called the “period of preparation.” The second period covers 2005–2010, and called the “period of development.” The third period is 2011, and called the “period of plateau.” The fourth period is 2012 to the present, and called the “period of transformation.” These divisions highlight important backgrounds of the flourishing of disaster education and activities for tsunami risk reduction, and furthermore highlight a transformation of practice and identity of participants. The impact of the Great East Japan Earthquake on disaster education is presented too.

The following is a summary of Chapters 2 to 6.

The primary objective of Chapter 2 is to describe the importance of balancing between being a survivor and being a supporter in disaster education. In this chapter I talk about the history of disaster education as conducted for over ten years in Okitsu village. In

particular, the content of disaster education is summarized by focusing on collaboration between community residents and students of Okitsu Elementary School.

During the period of preparation, the earthquake evacuation drill was introduced into Okitsu village. However, neither construction of infrastructure against disaster nor plans for disaster prevention were carried out. In 2005, the Okitsu Elementary School was selected as a model school to promote disaster education, so the Integrated Disaster Prevention Committee was established with the collaboration of community residents and the school. This initiates disaster prevention activities into the period of development. Since then, numerous achievements in disaster prevention in Okitsu were achieved regarding both infrastructure construction and plans for disaster prevention.

However, a serious problem was found in the attitudes of community residents toward tsunami risk reduction, marking the period of plateau. This problem was not taken seriously until the occurrence of the Great East Japan Earthquake. The specific problem was that community residents were divided into two groups, those very interested in tsunami risk reduction and eager to implement activities against disaster, and those indifferent to tsunami risk reduction and who rejected most activities proposed by the former group. Activities in these three periods are summarized based on the transformation of communities of practice in tsunami risk reduction. The contents of Chapter 2 are mainly based on a paper by Sun, Yamori, Kondo, and Tanisawa (2012).

Chapter 3 verifies the existential meaning of the serious problem revealed in the period of plateau. It summarizes the significant impacts of the Great East Japan Earthquake on local communities through the qualitative statistical data of a questionnaire survey. This chapter aims at discussing the transformation of configuration of tsunami risk reduction after the Great East Japan Earthquake.

Chapter 3 is made up of two parts. The first talks about impacts of the Great East Japan Earthquake, such as individual problems during tsunami evacuation, reappraisals of tsunami estimates due to a Nankai megathrust earthquake, and the problem of low tsunami evacuation rates in areas outside of Tohoku region despite evacuation warnings issued during the Great East Japan Earthquake. I then apply these three categories of problems to Okitsu village to discuss whether it was affected in the same way as other larger regions. The second part examines the results of the questionnaire survey, which find problems related to propagating the wisdom of tsunami *tendenko*, a strong reliance on disaster experts and government agencies, and attitudes that belittle the practice of tsunami evacuation.

Chapter 3 further confirms that problems of tsunami risk reduction triggered by the Great East Japan Earthquake are essentially formed by differing attitudes between disaster experts and community residents. Based on this finding, a new tsunami evacuation drill called the “single-person drill” was proposed. The following chapters describe the implementation and results of the single-person drill in detail. Chapter 3 is mainly based on a paper by Sun *et al.* (2013).

In Chapter 4 I talk about promoting disaster education and evacuation drills for tsunami risk reduction. Because the serious problems revealed in Okitsu village greatly hinder the development of tsunami risk reduction activities, new approaches are urgently needed to change the situation. With the introduction of the single-person drill and other methods, tsunami risk reduction in Okitsu reached a period of transformation.

This chapter describes negative attitudes toward tsunami risk reduction seen among community residents due to the reappraisal of tsunami predictions by central and local government agencies, which can be simply summarized into three types: overly optimistic, overly pessimistic, and overly dependent. The single-person drill is specifically proposed to alleviate these attitudes, for example by shifting tsunami risk reduction from the community level to the individual level. I thus focus on the identity transformations of participants to talk about how to motivate those who are overly pessimistic or dependent to take part in tsunami risk reduction activities.

This chapter describes the importance of studies of tsunami evacuation by focusing on both individuals and groups, using the methods of both the natural and human sciences. Chapter 4 is mainly based on a paper by Sun, Kondo, Miyamoto, and Yamori (2014).

In Chapter 5 I talk about the single-person drill by focusing on exceptional cases that have been seen in evacuees' behavior. Because the discussions in the previous chapters pay attention mainly to the general or average cases, this chapter provides different viewpoints to my ethnographic study on tsunami risk reduction. From the point of view of exceptional cases, I summarize the limitations of practice and study that focus on groups and average general people. I furthermore suggest the importance of paying attention to exceptional cases, to find concrete and practical methods for tsunami risk reduction.

From the results of the single-person drill, I find that participants can be categorized into three types: designers, campaigners, and life changers. Designers reject the methods of the single-person drill and design new methods based on their own condition or relationships with other residents. Campaigners express great interest in the single-person drill and extensively campaign for it. Life changers gradually change their own attitudes and behaviors toward tsunami evacuation. At the same time, life changers have others changed stereotypical images toward themselves.

Each type of participants applies unique artefacts to the single-person drill, which not only benefits their own practice, but also makes contributions to the development of the drill. In this way, owing to new practice and new artefact, community residents are cast as both survivors and supporters. This chapter pays special attention to identifying the significant meaning of collaboration between "research experts" and "practice experts" in action research.

Finally, Chapter 6 summarizes the results of this thesis, and describes the configuration of tsunami risk reduction and possibility of applying the methodology of this research. It consists of two parts: one analyses the practical implication for tsunami evacuation

and disaster education, and the other discusses the theoretical contribution to communities of practice.

Notes

¹⁻¹ In Japan, there are two types of firefighters. One is called public firefighters who serve for organizations established by the Fire and Disaster Management Agency. The other is called local volunteer firefighters who specifically serve for local communities as volunteers.

¹⁻² According to Yamori (2012), tsunami *tendenko* refers to an “everyone for him/her-self” mindset, which calls for a quick tsunami evacuation without waiting for others, not even one’s parents or children.

¹⁻³ According to the Municipality Merger Promotion Law, Kubokawa town merged into Shimanto town on 20 March 2006.

¹⁻⁴ Habitus is a set of cultural principles that generate in a coherent fashion the modes of activities, the life style and tastes, and the interests of a group, using a social class (Wenger 1990:146).

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Chapter 2

Disaster education from the perspective of communities of practice

2.1 Introduction

This chapter presents achievements and problems of disaster education as conducted for over ten years in Okitsu village regarding lessons learned from the Great East Japan Earthquake. In Japan, disaster education has achieved many successes in the past. However, the Great East Japan Earthquake also revealed significant problems. I summarize strengths and weaknesses of past disaster education into three categories: community resident participatory activities, soft countermeasures centred disaster education, and common products of disaster education such as disaster prevention manuals, hazard maps, and community disaster maps²⁻¹.

Based on these three categories, I analyse data collected from written records and interviews in Okitsu to present concrete examples of the achievements and problems of disaster education. To make a holistic analysis of these contents, I apply the theory of communities of practice to make theoretical considerations.

Section 2.2 summarizes the achievements and problems of general disaster education. Section 2.3 presents concrete examples of achievements and problems by analysing disaster education as conducted in Okitsu. Finally, Section 2.4 gives a theoretical discussion from the perspective of communities of practice.

2.2 Achievements and problems of general disaster education

Because of the high frequency of natural disasters, Japan has become one of the most advanced countries in disaster prevention. Before the Great Hanshin–Awaji Earthquake, infrastructure construction was the primary approaches, but in recent years, attention has been paid to soft countermeasures such as disaster education, evacuation drills, and related disaster prevention activities. All of these efforts have contributed to improving performance in terms of citizens' continuous participation. Among these practice, disaster education has been widely acknowledged as an important role in raising awareness and promoting disaster prevention in local communities.

After the Great Hanshin–Awaji Earthquake that happened in 1995, the general policy of disaster prevention shifted from infrastructure construction-based approaches to soft countermeasures. Participatory approaches to disaster education were introduced into schools and communities to promote risk awareness among students, parents, and community residents. Several successful cases of tsunami evacuation during the Great East Japan Earthquake presented the great contributions made by continuous disaster education. For example, Noda village kindergarten, located only 500 m from the seacoast in Iwate prefecture, achieved a 100% evacuation rate of 94 children under the age of five

(Chunichi Shimbun 2011). Similarly, the elementary and junior high schools in Kamaishi, with a total enrolment of 2,921 students, achieved an evacuation rate of 99.8% (Kahoku Shimpō 2011).

Although disaster education in Japanese society has been improved dramatically, difficult problems remain. I summarize the achievements and problems into three categories that include both deficiency and importance of disaster education. The three categories are described as follows: community resident participatory activities, soft countermeasures centred disaster education, and common products of disaster education such as disaster prevention manuals, hazard maps and community disaster maps.

2.2.1 Three categories

Community resident participatory activities

In the field of disaster education, two aspects are usually considered to be important. On the one hand, it is important for community residents to assimilate knowledge and skills that are provided by disaster experts. On the other hand, it is also necessary for them to take part in resident participatory activities to enhance mutual risk communication or mutual help within their communities. Since recent natural disaster occurs on larger scale, and becomes more diverse and more complicated than before, it is impossible for community residents to rely entirely on the public agencies to rescue them under emergency conditions. As a result, local volunteer firefighters, who are familiar with their local communities and neighbors, are highly expected to perform the roles of emergency rescuers. Watanabe (2000) introduces that, a town walking activity called “rediscover our community,” which is conducted by a non-profit organization and community organizations, gets very popular in local communities. During the town walking, dangerous areas in the community are carefully investigated and responding countermeasures are suggested by residents themselves, which can eventually promote their concerns toward natural disaster. In this way, to promote the community resident participatory activities is recognized as an important approach to disaster education.

However, there are potential problems and risks in the participatory practice as well. For example, most of the results of the participatory disaster education are only summarized on vellum or written into notes, instead of functioning well to motivate community residents to take part in some actual and effective activities. Also, due to the superficial collaboration among disaster experts, government agencies, and community residents, if the safety of evacuation routes or evacuation shelters suggested during participatory disaster education was not verified scientifically, serious damage and casualties would be caused by an actual disaster (Ushiyama 2008). Similarly, as mentioned in Chapter 1 that, because vast number of casualties of local volunteer firefighters died while trying to evacuate other people during the Great East Japan Earthquake, the limitation of the wisdom of mutual help was explicitly revealed in local communities.

Soft countermeasures centred disaster education

On the one side, based on lessons learned from the Great Hanshin–Awaji Earthquake, it is plain for all to see that, to promote countermeasures against disaster, we have to

transform the direction of disaster prevention from infrastructure construction to the implementation of soft countermeasures. Generally speaking, it is impossible to prevent natural disaster if we just rely on infrastructure. For example, when users of the infrastructure are indifferent to disaster prevention, or they are ignorant about vital information or knowledge of disaster risks, then the actual effectiveness of infrastructure would be probably lowered. Specifically, from the successful evacuation case of elementary and junior high school students in Kamaishi, we can see the significance of promoting software countermeasures against disasters.

However, on the other side, it is also impossible to protect people's lives from disasters if we only depend on soft countermeasures. The effectiveness of infrastructure has been verified during the Great East Japan Earthquake, and some reports state: "It is clear that the infrastructure did not function well to prevent the destructive tsunami from reaching people's homes. Nonetheless, the infrastructure has earned more time for people to evacuate. To some extent, it has played an important role to reduce inundated area" (Cabinet Office 2012). In addition, because some local volunteer firefighters lost their lives when trying to close the water gates, we can see that there is an absolute necessity to upgrade and improve the construction of small-scale infrastructure. For example, it might be helpful to remove the water gates or develop remote operational systems to control the opening and closing of water gates.

Meanwhile, according to the results of several surveys about tsunami evacuation behaviors during the Great East Japan Earthquake, it is found that whether people were capable or incapable of "receiving tsunami information via community wireless loudspeaker, radio, or warning vehicle before evacuation" would become the boundary dividing life from death. For example, according to a cooperative survey made by the Cabinet Office, Fire Disaster Management Agency, and Japan Meteorological Agency (2011) in the refuges and temporary houses in Tohoku area, more than half of the disaster affected residents responded that they had received both tsunami information and evacuation warnings. The concrete figure turned out to be 87% in Iwate prefecture and 79% in Miyagi prefecture. According to the report of CeMI (2011), tools used for receiving information are that, the community wireless loudspeaker turned out to be the first choice (43.9%), followed by radio (24.3%), firefighting vehicle or warning vehicle (16.8%), family members or neighbors (13.1%), and TV (7.5%). In some areas which were seriously struck by the Great East Japan Earthquake, power failure and building collapse made it impossible to receive any information on TV. Thus, small-scale infrastructure such as community wireless loudspeaker, radio, and warning vehicle, which are popular equipment for information distribution in local communities, have made great contributions.

Disaster prevention manuals, hazard maps, and community disaster maps

Recently, it is realized that how to provide and share disaster information with community residents is very important for almost all of the disaster prevention activities. In the field of tsunami risk reduction for example, it suggests that, in order to reduce human sufferings via appropriate evacuation, it is useful to provide the evacuation information for community residents or to upgrade disaster prevention manuals. According to the

report of reappraised estimates of a Nankai megathrust earthquake and tsunami, many municipalities on the Pacific coast start to rethink about the previous disaster prevention manuals as well as tsunami evacuation plans.

The importance of hazard maps and community disaster maps is stressed because they are effective tools to promote self-reliance abilities of community residents as well as to enhance people's understandings of disaster risk. For example, in the 1998 East Japan Heavy Rain, the 2000 Tokai Heavy Rain, and the 2000 Mt. Usuzan Eruption, quick and smooth evacuations were achieved owing to the effective use of hazard maps by community residents (Katada 2002).

The disaster prevention manuals, hazard maps and community disaster maps are useful but they have limitations on information distribution. With the disaster prevention manuals, government officers are able to give the correct warning information without any difficulties. It is such an easy way that they do not have to understand the complicated decision-making process of issuing such warning information. Of course, it is not their responsibility to consider about the possible negative results of the warning distribution as long as they act exactly as they have been told by the manuals. In this sense, we can conclude that the disaster prevention manuals have a pair of paradoxical function. They tell people "what have to do" and "what do not have to do" (Yamori 2011).

For the hazard maps and community disaster maps, they are very useful to visualize the whole situation of flood inundation or evacuation behavior in a large region. However, because most of the hazard maps and community disaster maps are produced by research experts or practice experts, they are not very useful for personal individuals who need local concrete information rather than the whole situation (Yamori 2011). Conversely, Ushiyama (2008) points out that the scientific knowledge would be misunderstood or distorted if the contents of community disaster maps have not been strictly verified based on professional knowledge.

2.2.2 Relations among three categories

In fact, the three categories mentioned above do not exist independently, but have intimate relations with one another. For example, there are different attitudes between people who use the infrastructure such as sea levees and people who construct the infrastructure. Users are usually represented by community residents or people who make a life on the coast. Constructors are usually represented by government officers, engineers, and disaster experts. Okayasu *et al.* (2007) argues that users are inclined to doubt the effectiveness of the infrastructure, so they require more constructions to protect their lives from disaster. Conversely, constructors are satisfied with the status quo, so they expect more soft countermeasures to be conducted by users. From these points of view, we can clearly see that there are intimate relations between community resident participatory disaster education and soft countermeasures centred disaster education and infrastructure construction.

Moreover, during the Great East Japan Earthquake, there were more than 30 minutes for Kamaishi citizens to make an evacuation before tsunami arrived in. However, according

to the report of Sankei Shimbun (2011), approximately 65% of the 1032 fatalities among Kamaishi citizens occurred in regions designated as safe from tsunamis, according to hazard maps issued by the local government in 2005. In the Sankei Shimbun's report, Katada points out that: "If people believe that they are living in safe areas according to the information written on hazard maps, they are very likely not to make an immediate evacuation even under stress conditions." Though hazard maps and community disaster maps have positive functions to reduce disaster damage, they may also have negative functions to enlarge the damage. In fact, information provided by the hazard maps only covers "what we know at present," it cannot tell us "what will happen in the future." This is definitely vital information that requires the users to keep in mind when using hazard maps. From this point of view, we can conclude that there are close relationships among the three categories.

Therefore, to promote disaster education in local communities, we have to take the three categories as a whole to think about appropriate countermeasures against disaster. To show a concrete practical case in local communities, I introduce the disaster education conducted for over ten years in Okitsu.

2.3 Disaster education in Okitsu

2.3.1 Methodology

In this section, to introduce the disaster education in Okitsu, I apply qualitative methods to analyse archival materials, interview results, and field notes. Archival materials are mainly collected from Okitsu Elementary School. I consult news reports on disaster prevention in Okitsu from the national and local newspapers such as Asahi Shimbun, Yomiuri Shimbun, Mainichi Shimbun, and Kochi Shimbun. I focus on the period of news reports from January 2000 to December 2011. I make interviews with school-teachers, community residents, and local government officers. Through these interviews, I get more detailed information, especially information about the background of the disaster education at early stages, which further elucidate the status quo. All the information is summarized in chronological order. Based on this order, the history of disaster education in Okitsu is divided into three periods, where transformations of its configuration are discussed respectively.

2.3.2 Okitsu village

Before talking about the disaster education, it is necessary to give detailed information about the geographical location and the demographic composition of Okitsu. In Chapter 1, I have described the information briefly from the point view of disaster prevention. Here, I want to give more details on the background of the disaster education.

Okitsu is situated at the south-western coastal area in Shimanto town, Kochi prefecture. Its southern boundary is formed by Tosa Bay, and the other three sides are surrounded by mountains. Okitsu is completely surrounded by mountains to the northwest and the sea to the southeast, as shown in Figure 2.1. Along the Tosa Bay, there are no roads leading to nearby towns. The only transportation line is Road No.52, which is a classic

example of a narrow, winding mountain road, and has more than 140 curves in its 18 km length (see Photo 2.1). The road can easily be shut down by a landslide or earthquake.

Okitsu is made up of three small communities called Omuro, Urabun, and Gobun, respectively. Omuro and Urabun are formed alongside fishing ports. Their community residents primarily make a life on fishery. Gobun is formed alongside mountains, and agriculture is the primary source of income for residents. In addition, because of the famous beautiful Omuro Beach, there are tourist businesses such as sea bathing, diving, and surfing in Okitsu.

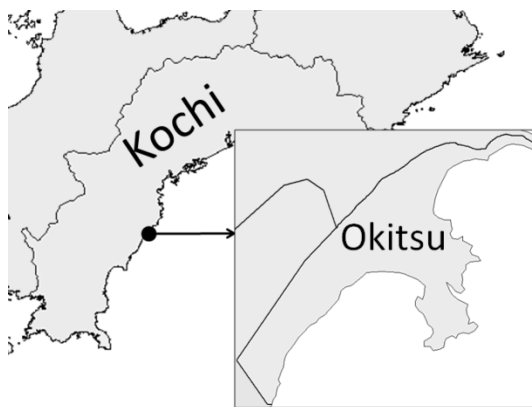


Figure 2.1 Okitsu village in Kochi prefecture



Photo 2.1 Okitsu village (The front is the Pacific Ocean. On both sides of the mountain, there are two fishing ports. A line appear indistinctly is the narrow mountain Road No.52)

As of 1 April 2013, there are 161 households and 294 people living in Omuro. Because most of the houses in Omuro are built on steep slope areas and there are no sea levees constructed along the Omuro fishing port, the community is easily to be directly destroyed by tsunami waves.

Urabun has 193 households and 319 people. Most of the population in Urabun are older people, and many people are over the age of 75. Urabun has the highest rate of aging population in Okitsu. All the houses are built alongside the Urabun fishing port, which makes the intensity significantly high. In addition, most of the houses are built with timbers, and community roads are very narrow. If the community were struck by a big earthquake, then there will be many collapsed houses and closed roads which would hamper residents' quick evacuation.

Gobun has 197 households and 378 people. Compared with the other two communities, Gobun has more plain land. Also, instead of building brick walls, Gobun residents in-

herit their communities' traditional culture to plant bamboos around their houses. As bamboos walls do not collapse during earthquake, evacuation routes can be definitely ensured in this community. Nonetheless, it is comparatively far away from the residential areas to evacuation shelters, so it is difficult to make an evacuation on foot for older people.

For Okitsu, the latest devastating tragedy was the Showa Nankai Earthquake in 1946, memories of which were passed down in the form of narrative stories by older people. Before the Great East Japan Earthquake, estimates predicted that tsunami would arrive within 18 minutes after the occurrence of an anticipated Nankai earthquake, and the highest wave would run up to 12 m. To cope with the risks of earthquake and tsunami, community residents in Okitsu village started to engage in disaster education from an early period.

2.3.3 Three periods of disaster education

Based on data collection, the historical disaster education conducted in Okitsu can be divided into three periods: the preparation period, the development period, and the plateau period.

The first period: Preparation before 2004

In memory of the first anniversary of the Hanshin–Awaji Earthquake and the 50th anniversary of the Showa Nankai Earthquake, and also to prepare for future anticipated earthquakes triggered by the Nankai trough, evacuation drill was introduced into Okitsu in 1996. At first, the drill was mainly organized by the Fire Department of Shimanto Town, but was gradually taken over by Okitsu Voluntary Organization for Disaster Prevention. However, the implementation of evacuation drill cannot satisfy the urgent needs of disaster prevention.

According to Asahi Shimbun (2002), both community residents and local government agencies realized the importance of constructing infrastructure such as evacuation shelters. For example, one of the community leaders said, “If tsunami comes, both our people and our properties, even the whole village will be completely destroyed. What’s worse, the seawater cannot drain out because it will be blocked by the sea levees. It is really necessary to construct evacuation shelters. But we don’t have financial budget.” Some residents said, “Our only transportation line, the Road No. 52, will be totally destroyed by a large earthquake. Isolation is also one of the biggest threats to us.” Local government officers said, “Right now, we don’t have any disaster prevention plans for Okitsu yet.”

For school disaster education, Okitsu Elementary School started to make community disaster maps in 2004 by using the integrated study period, which was newly created in the national curriculum in 1998. However, according to results of semi-structured interviews with schoolteachers, I found that, during the disaster education, teachers focused only on how to inculcate skills and knowledge of map-making to students. That is to say, teachers played the roles of “people who can teach,” on the one hand. On the other hand, school students were treated entirely as “people who should learn.” Efforts put in

the disaster education only confined within the classroom instead of making contributions to the general disaster prevention in local communities.

The second period: Development from 2005 to 2010

Disaster education that was promoted by the collaboration between Okitsu Elementary School and the village started in August 2005. The MEXT instructed the Okitsu Elementary School to implement participatory disaster education with community residents for a single year, during which a total of 1.3 million yen was provided as financial funding. Meanwhile, Okitsu village also got financial budget from Kochi prefecture to repair fishing ports and to construct evacuation shelters. Thus, it was easily to bond together the school and the village to promote disaster education.

In consideration of giving back achievements of the disaster education to community residents, the headmaster of Okitsu Elementary School and the *osodai*²⁻² of Okitsu village worked together to establish the Integrated Disaster Prevention Committee and both of them served as representatives of the committee. The committee consists of community leaders, president of the Parent-Teacher Association, town councillors, leaders of Okitsu Voluntary Organization for Disaster Prevention, and president of the senior citizen club. In a word, people who had served as leaders or representatives of any organization in Okitsu joined the committee.

In this way, the stage for promoting activities of disaster education was provided officially, which was proved to be significantly important for communities like Okitsu. There were historical conflicts among the Omuro, Gobun, and Urabun communities, such as competitions on sources of livelihood, different attitudes toward whether to vote for a nuclear power plant to be constructed near the village in 1980s. Without the committee, it was impossible for the three communities' residents to work together. Therefore, ever since the disaster education was introduced, emotional conflicts among community residents have been largely mitigated. That was, how to promote disaster education effectively became a common objective for all the residents.

At the same time, school students also got a position in local disaster prevention. For example, M. Matsuoka, the former headmaster at Okitsu Elementary School said: "No matter how seriously the school students criticized the countermeasures against disasters in the village, no one blames them. Students are precious kids in this aging village, and they do not have any concern for the financial and political interests." Activities of disaster education are mainly implemented by students, so it is easy for all the members of the Integrated Disaster Prevention Committee to work together to consider resolutions to the same problems. During the disaster education, school teachers and community residents give great encouragement to students, asking them to give out their own ideas and suggestions actively. "I think that's why lots of disaster facilities are able to be constructed quickly in recent years," Matsuoka added.

In 2005, although there were only 46 students in Okitsu Elementary School, various activities of disaster education have been conducted. For example, there were quarterly newsletters of disaster prevention distributed to all the families in the village, drills for

rescuing injured people, community disaster map-making, community kitchen cooking, and night-time camping. Table 2.1 shows that at least ten times of activities were implemented from 2005 to 2010. During these activities, especially through community disaster map-making in particular, students discovered many problems in the village. They noted that piers of bridges located on evacuation routes were in disrepair; that steep routes were difficult for older people and would be easily damaged in the event of a large earthquake; and that the kindergarten and day-care centre were located on the coast, even if both users were considered to be the most vulnerable people in disasters.

In the end of 2007, the Integrated Disaster Prevention Committee convened a symposium on disaster education. They invited community residents, local government officers, disaster experts, and journalists. Students pointed out dangerous areas concretely by using disaster maps that they made. They said: “The Okitsu kindergarten and the day-care centre situated on the seaside are just three meters high. When tsunami comes, both of them are definitely to be inundated. As their users are small children and older people, it will take more time for users to make tsunami evacuation. In addition, the bridge on the evacuation routes is supposed to be destroyed in an earthquake.” In response, S. Funamura, who serves as the representative of the Integrated Disaster Prevention Committee, said: “Resolutions to disaster risks, especially relocation of the kindergarten and senior day-care centre are urgently demanded by all of the residents.” Amazingly, the local town governor made an improvised announcement at the symposium, saying, “I promise that the relocation of kindergarten and day-care centre will be accomplished by the end of 2009.” As a result, the kindergarten and day-care centre were relocated to a higher place and merged into a complex facility. The facility which usually is called “Okitsu kindergarten” has been designated as an evacuation shelter.

Table 2.1 Disaster education activities at Okitsu Elementary School

Contents	Year (frequency)					
	2005	2006	2007	2008	2009	2010
Meetings of the Integrated Disaster Prevention Committee	2	2	2	0	4	2
Visiting to advanced disaster prevention areas	2	1	2	1	1	0
Issuing of disaster prevention newsletters	3	2	3	1	2	3
Fieldworks for disaster map-making	2	1	7	4	5	1
Disaster prevention symposium	1	3	5	7	3	6
Evacuation drill	1	1	4	2	1	2
Community kitchen cooking or nighttime camping	1	0	3	1	2	1
Awards	0	0	2	3	3	2
Total	12	10	28	19	21	17

In addition, other facilities which were potentially at risk, such as dilapidated bridges and evacuation routes, were reconstructed after serious discussions with local government. Without such collaboration among the school, the village, and the government, students' efforts probably would not even be considered as part of activities of local disaster prevention. In 2008, the community disaster maps made by students won the highest award from the Disaster Prevention Minister of Japan in the fourth Disaster Mapping Contest (General Insurance Association of Japan 2007). One year later, in 2009, the improved version of the maps received the Koshien Disaster Management Award from Disaster Reduction and Human Renovation Institution, which is a famous disaster memorial museum established in 2001 to commemorate the Great Hanshin-Awaji Earthquake (Hyogo Prefecture 2009).

Since then, Okitsu became a well-known village for its advanced disaster education, both in and out of Kochi prefecture. The total number of visitors to Okitsu from 2005 to 2010 amounted up to almost 450. This means 90 visitors per year, or 7.5 visitors per month, on average. Owing to such visitors, relationships between the insiders and outsiders have been established, which furthered the development of disaster education greatly on both sides.

The third period: Plateau revealed in 2011

Although Okitsu is located far away from north-eastern coastal areas in Japan, the Great East Japan Earthquake exerted a great impact on the village which forced the community residents to revise disaster education and to re-evaluate their past achievements. At the same time, I took part in the disaster education as an outsider from November 2011. Since then, I continue to visit the village at least once a month. My activities include introducing precious lessons learned from the Great East Japan Earthquake, giving suggestions to the improvement of evacuation routes and emergency storage. Of course, other researchers such as my supervisor also participate in the disaster education and give practical advices. Regarding lessons learned from the Great East Japan Earthquake that some evacuation shelters were inundated by ferocious tsunami, researchers suggested that evacuation routes to higher places from the existing shelters should be constructed. Researchers also shared academic knowledge and practical experiences, and invited people who experienced the Tohoku tsunami to talk about evacuation skills.

The school, the village, and the local government adopted these advices enthusiastically. Specifically, school students participated in tsunami evacuation drills and conducted fieldworks for community disaster map-making more frequently than before. The village held several disaster education symposiums to learn tsunami evacuation experiences and started to consider the construction of evacuation towers.

Currently, as shown in Figure 2.2, evacuation facilities in Okitsu village consist of six evacuation shelters, four evacuation towers, five evacuation routes, and one heliport. Evacuation shelters and towers can accommodate up to 2200 evacuees, far exceed the whole population. To ensure people from every place in the village can arrive at an evacuation facility before tsunami comes, evacuation routes have been paved recently. Also, because the Road No.52 may be shut down after an earthquake, a heliport was

constructed in order to transport food or injuries immediately. To ensure evacuees can make a life when the village is isolated from outside regions, storehouses for food, stove burners, blankets, and mattresses have been established in every evacuation shelter and tower. To prevent evacuees from hot sunshine, cold wind and rain, log cabins have been constructed in evacuation shelters. In addition, according to the latest tsunami predictions published by Kochi Prefecture (2012), heights of the existing evacuation towers turned out to be not high enough, thus reconstructions of them are well under way. As a result, Okitsu is famous for not only its advanced disaster education, but also its advanced hard construction of infrastructure against tsunami risks.

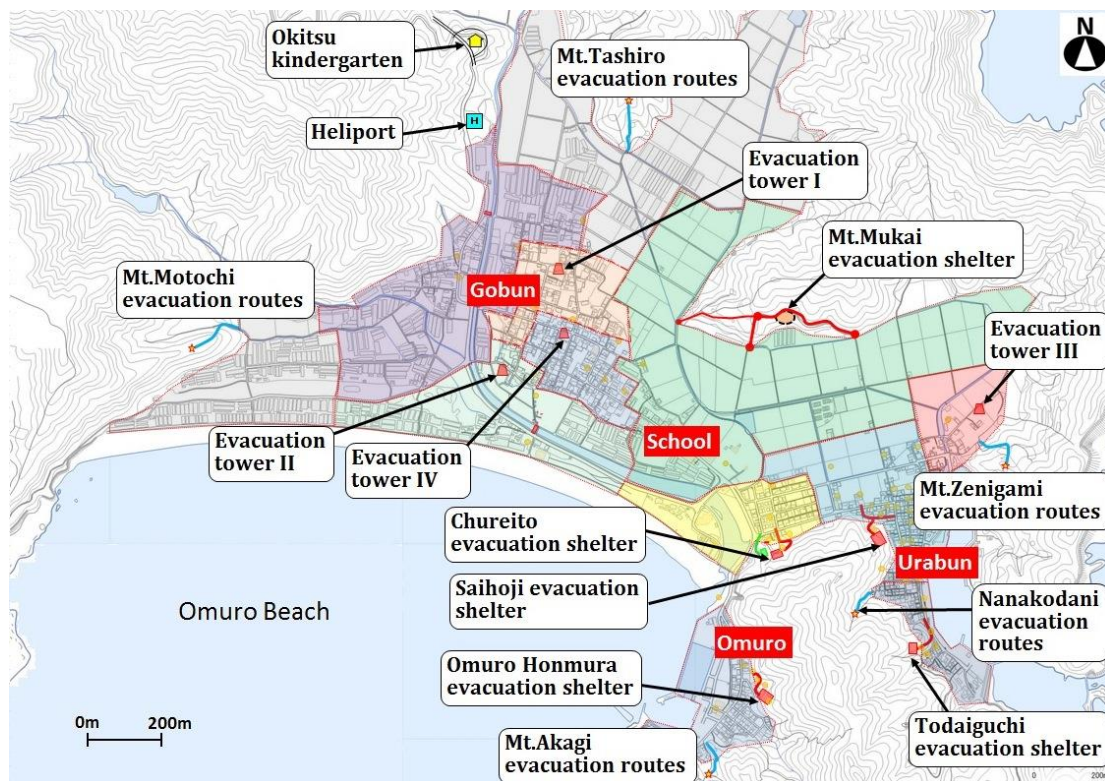


Figure 2.2 Evacuation facilities in Okitsu village (as of May 2013)

However, in Okitsu village, there is a serious problem of polarized attitudes toward tsunami risk reduction. The problem revealed as that, some community residents have high interest in disaster prevention activities, but others do not. More achievements of disaster prevention, more serious the problem became. According to a questionnaire survey conducted in Okitsu village in January 2012, contents of the problem are shown as “Residents are inclined to wait for more information before actually make an evacuation,” and “Residents reject the wisdom of tsunami *tendenko* to make an independent evacuation.” The results indicate that challenges of tsunami risk reduction in Okitsu are still comparably serious, which need the community residents to put in more efforts to

consider resolutions. All of these problems revealed in the period of plateau will be discussed in great detail in Chapter 3.

2.4 Theoretical consideration

With the theory of communities of practice introduced in Chapter 1, I give theoretical discussions about the disaster education in Okitsu village. I apply those three key concepts—artefact, practice, and identity to the discussion. Also, those three problems pointed out in Section 2.2—community resident participatory activities, soft counter-measures centred disaster education, and common products of disaster education—are analysed thoroughly in Okitsu's disaster education.

Specifically, in Subsection 2.4.1, artefacts such as community disaster maps are discussed from the perspective of practice and identity of participants. In Subsection 2.4.2, artefacts such as the Integrated Disaster Prevention Committee are analysed from the perspective of different functions. Meanwhile, the background of tsunami risk reduction problems revealed in the third period is found exactly as the consolidated identities of participants. Finally, in Subsection 2.4.3, to overcome these problems, it is necessary to transform relationships among the three key concepts in communities of practice through collaborative activities.

2.4.1 Two types of community disaster maps

There are two different types of community disaster maps in the first and the second periods in Okitsu's disaster education. They were both illustrated by Okitsu Elementary School students. In the first period, during the map-making process, teachers played the role of people who can teach through giving knowledge and skills. School students were treated entirely as people who should learn. Thus, functions of this kind of community disaster maps, the so-called artefacts in communities of practice, were that they supported the stereotypical identities of participants without forming connections to local activities. Through the production of artefacts, participants did not acquire the identities of partners in local disaster prevention, but were constrained strictly in the classroom.

In contrast, during the second period, the community disaster maps functioned as artefacts which bonded together the practices of school students and community residents. At the same time, new artefacts also have been produced gradually during the production process of community disaster maps. That is to say, firstly, the community disaster maps make contributions to the stability of artefacts such as the Integrated Disaster Prevention Committee. Secondly, the community disaster maps urge the relocation of kindergarten and day-care centre from the seaside to higher places. The maps also contribute to constructions of new evacuation facilities. Other examples include cooperative networks that were established between insiders and outsiders of Okitsu village, which eventually generated new practice such as lots of outside visitors.

Owing to the community disaster maps, artefacts have motivated new disaster education practice, which in turn new artefacts are developed. For example, evacuation shelters have been used to carry out evacuation drills. Discussion of tsunami risk reduction is-

sues with disaster experts is obviously a type of practice, which has the potential to create more artefacts such as evacuation routes. In a word, circular interactions were formed as “artefact → practice → artefact → practice.”

Through the interactions, the identities of participants were gradually changed. For example, problems in disaster management, which were pointed out by school students, have been addressed by residents and government officers. These serious issues eventually resulted in new construction, such as evacuation routes, during which the identities of various participants have been changed. Specifically, the identities of students have been transformed from those who learn in the classroom to partners in the tsunami risk reduction. Similarly, the identities of community residents who engaged in the disaster education have been transformed from uninterested individuals to active participants, as was also the case of other participants such as schoolteachers, disaster experts, and journalists.

In terms of community disaster maps and hazard maps, Yamori (2011) pointed out that it was important to pay attention to the interactions and mutual relationships among various participants. That is to say, to see what has been written on the maps is a secondary issue, but to see what kind of practice has been made during the map-making process is the primary issue. In Okitsu village, the community disaster maps played the important role as artefacts to transform the identities of many participants.

In this sense, the essential meaning of the disaster education in Okitsu village can be seen clearly. During the second period, all the achievements of software countermeasures are directly given back to the local communities, such as the hardware construction of infrastructure. This kind of disaster education is what I have argued in Chapter 1 as raising supporters. Though activities based on this policy still continues after the Great East Japan Earthquake, tsunami evacuation drills and fieldworks of school students mentioned in Subsection 2.3.3, were conducted more frequently than before. This indicates that the disaster education in Okitsu village well balances between being a supporter and being a survivor.

2.4.2 Integrated Disaster Prevention Committee

Established in 2005, the Integrated Disaster Prevention Committee was initially suggested by the MEXT and established smoothly with the cooperation of Okitsu Elementary School and Okitsu village. More importantly, the initial instruction from the MEXT requested the school headmaster to serve as the single representative of the committee, but in order to give back achievements of disaster education to local communities, the school headmaster and *osodai* suggested having double representatives on the committee.

After one year's practice, both the school and the village intended to continue the disaster education, even though the financial funding from the MEXT had expired. Therefore, both representatives worked together to appeal to the local government and ultimately received official support. This indicated how the Integrated Disaster Prevention Committee was able to bond together the school and the village. As Sugiman (2006) propos-

es that when the symbolic objects reappear frequently or repeat over time, they gradually become stable objects that have the same functions as physical ones. This indicates that, through the practice of disaster education, the Integrated Disaster Prevention Committee has already become an artefact. For example, evidence can be seen as follows. Before the school and the village move on to discuss further disaster prevention plans, they have to report to the Integrated Disaster Prevention Committee or talk about these issues with members of the Integrated Disaster Prevention Committee.

As an artefact, the Integrated Disaster Prevention Committee functions as a visible object which makes great contribution to the disaster education. For example, it provides support to the fieldworks of community disaster map-making, to establish more evacuation facilities, and to improve evacuation stores. These artefacts are all produced through collaborative practices. Meanwhile, due to these artefacts and practices, identities of participants have been transformed concurrently. For example, people changed their attitudes toward disaster prevention, from thinking that it was the responsibility of the government agencies, to realize that it was essentially their own responsibilities. If someone who did not have any interest in doing disaster prevention, but recommended him/herself as cook on the community kitchen, then his/her motivation for participating in disaster prevention activities would be promoted through the interaction of those three key concepts of communities of practice.

However, negative outcomes of disaster education have also accelerated rapidly and steadily, along with the positive achievements. Because of the development and stability of artefacts such as the Integrated Disaster Prevention Committee and evacuation facilities, relationships among participants would become inactive. That is to say, the three key concepts of communities of practice interlock with and confine each other at the same time.

For example, due to the stability of artefacts, community residents ask the Integrated Disaster Prevention Committee to require more funding on the constructions of evacuation facilities from the local government, or they doubt effectiveness of evacuation towers that had been constructed according to the results of discussions of the Integrated Disaster Prevention Committee. The accomplished evacuation facilities have hindered the enhancement of risk consciousness among residents. Residents have formed a tendency to depend on others to take charge of disaster prevention activities, and to rely too much on existing infrastructure such as sea levees. On the other hand, people who have made great contributions to the constructions of evacuation facilities, said: “*We* take responsibility to make construction, *you* only have to make evacuations.” These phenomena revealed that community residents have been divided into a polarized group invisibly. One group has high interest in disaster education, but the other does not. According to the results of semi-structured interviews with residents, the former group can be represented by “*We* work so hard on disaster prevention, but *you* do not follow up.” The latter’s opinions can be represented by “*We* put our trust in the Integrated Disaster Prevention Committee to do disaster prevention,” or “Members on the Integrated Disaster Prevention Committee just like to do disaster prevention in their own ways.” The two groups generated opposite attitudes toward disaster prevention too. Furthermore, the

attitudes get consolidated along with the advanced development of disaster prevention. With the ossified artefacts such as the Integrated Disaster Prevention Committee, subsequent practices and identities become inactive too. This is the existential meaning of problems revealed in the third period of plateau.

To overcome these problems, firstly, it is necessary to make clear about the concrete contents. In the next chapter, a questionnaire survey is conducted in Okitsu village specifically to grasp the contents. Meanwhile, based on survey results, a new approach called “single-person drill” is proposed and implemented with the collaboration of Okitsu Elementary School, the Integrated Disaster Prevention Committee, the local government, and researchers through action research. Also, detailed information of the single-person drill will be described in Chapters 4 and 5.

2.5 Conclusion

In this chapter, I discussed the disaster education in Okitsu from the perspective of the theory of communities of practice by applying three fundamental concepts. It is important that various participants, including people who are outsiders, have potential ability to gradually change relationships among the artefact, practice and identity in disaster education. From a certain perspective, even the validity of the contents described in this chapter is threatened by the flexible relationships. Because when the disaster education is written in papers, or reported by journalists, it is very likely that outsiders have chances to participate in and exert influence on the disaster education. At the same time, outsiders might make contributions to improve the disaster education by collaborating with insiders. Action research is such a research stance that aims at achieving better conditions for local communities with the collaboration between researchers and co-researchers.

Of course, proposals for new practice cannot be suggested without analysis of the past. For example, practice of the single-person drill is proposed based on participation of researchers for a long period of time. During participation, researchers make analysis of past archival materials, conduct questionnaire surveys and semi-structured interviews. Achievement of the single-person drill will be discussed in the following chapters, but here, I want to cite some comments from a co-researcher to show the basic stance of action research. The co-researcher said: “I think the single-person drill will work smoothly, because it is an extended practice of our past activities.” This indicates that as a new challenge to the disaster education, the single-person drill is exactly expected by co-researchers.

Notes

²⁻¹ Generally, hazard maps contain scientifically calculated hazard information and are used as basic tools to provide standardization for establishing warning systems, giving evacuation orders, and drafting regulations of land use. In contrast, community disaster maps are mainly made by community residents themselves, though taken disaster experts’ advice into account now and then. Recently, by making community disaster maps

to motivate residents' active participation in disaster prevention become very popular in Japanese communities.

²⁻² There are three persons serving as *sodai* in the three communities of Okitsu village. Responsibilities of *sodai* are to organize local events such as community kitchens, to plan the cleaning of street gutters, and to select caretakers for some older people. At the same time, one *sodai* serves as *osodai* to take charge of the projects of disaster prevention in Okitsu. At present, *osodai* is S. Funamura, who serves as Omuro's *sodai*. Funamura also serves as the president of Okitsu Voluntary Organizations for Disaster Prevention. Supported by the other two *sodais*, he gives decision makings of disaster prevention projects, such as the relocation of fire equipment storehouses, and the negotiation of infrastructure construction such as evacuation shelters.

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Chapter 3

Consciousness of disaster risk and tsunami evacuation

3.1 Introduction

Major problems related to tsunami evacuation revealed in the Great East Japan Earthquake have been widely discussed, and recently attention has shifted to preparedness for a Nankai megathrust earthquake. There is a high probability that such an earthquake will occur in the near future. Preparations should therefore be made in each community where damage is expected.

Based on results of a questionnaire survey, this chapter discusses the Great East Japan Earthquake's impact on the village of Okitsu in Kochi prefecture. It also provides detailed information about problems related to disaster education revealed in the plateau period. In addition to finding resolutions to these problems, I suggest tsunami disaster countermeasures for coastal areas where tsunami damage is expected. In these areas, various disaster prevention activities were introduced and implemented before 2011. However, in response to newly revealed problems, new approaches are required.

This chapter focuses on the following specific issues in tsunami evacuation. Firstly, individual-level topics in tsunami risk reduction such as using vehicles for evacuation. Secondly, challenges initiated by government reappraisals of tsunami estimates such as the safety of existing evacuation shelters. Thirdly, low tsunami evacuation rates in areas at high risk of tsunami damage, despite evacuation orders issued during the Great East Japan Earthquake. Based on these discussions, I compare impacts between the Tohoku regions and the Nankai trough regions.

This chapter presents statistical data to verify the achievements and problems summarized in Chapter 2, especially the problem of polarized attitudes toward tsunami risk reduction between community residents. At the same time, I extend the scope of the problem considered, from individual residents to the practice of tsunami risk reduction in the village. Besides survey data, I provide additional information based on my ethnographic studies.

Section 3.2 summarizes the impacts of the Great East Japan Earthquake in three categories. Section 3.3 presents the specific details of these impacts by focusing on the awareness of disaster risk and tsunami evacuation among community residents in Okitsu. Finally, Section 3.4 gives specific reasons of why the single-person drill is suitable for action research in areas like Okitsu.

3.2 Impacts of the Great East Japan Earthquake

In the Great East Japan Earthquake, over 90% of the approximately 20,000 fatalities (including those still officially listed as “missing”) died from drowning, not the earthquake itself (National Police Agency 2012). The tremendous damage inflicted provides a clear example of how convincing residents to rapidly evacuate is among the greatest

challenges in disaster risk management. The potential for damage resulting from a Nankai megathrust earthquake has been discussed since even before 2011. Many local municipalities, related organizations, and residents have invested great energy into disaster mitigation measures, such as the construction of hardware facilities and the implementation of soft countermeasures, all of which were based on community-level conditions. However, the huge impact of the Great East Japan Earthquake has forced a re-evaluation of the likely effectiveness of these approaches.

In this section, based on the academic achievements obtained from action research conducted in Okitsu village (Kondo *et al.* 2012; Sun, Yamori, and Kondo 2013), survey data published by the government agencies (CDPC Report 2011, 2012), and reports of local municipalities (Kochi Prefecture 2012a, 2012b), I summarized the impacts into three categories. They are the individual-level topics of tsunami evacuation, government reappraisals of tsunami estimation, and low tsunami evacuation rates despite evacuation orders issued at the time of the Great East Japan Earthquake in specific areas. This section discusses each of these problems in detail.

Certainly, other issues also exist in tsunami risk reduction, such as short comings of existing evacuation shelters mentioned in Chapter 1, whether it is good to relocate houses to higher places, and whether it is necessary to adopt new methods of tsunami evacuation which include the construction of underground evacuation shelters and evacuation capsules. Though the impacts summarized here are not comprehensive, it is helpful to compare impacts between the Tohoku regions and the Nankai trough regions.

3.2.1 Three categories of impacts

Individual-level topics of tsunami evacuation have been summarized in detail in Chapter 1. For example, there are topics of elderly fatalities, vast death of local volunteer firefighters, and the use of vehicles to make an evacuation.

Government reappraisals of tsunami estimates have also been described in detail in Chapter 1. For example, the Cabinet Office (2012a, 2012b, 2012c) published a series of tsunami–earthquake estimates and related damage predictions. Influence of estimate reappraisals can be seen in re-evaluation of existing evacuation facilities in local municipalities.

A final problem for consideration is low evacuation rates. Expectations were that the residents of the Tohoku region had an even higher awareness of tsunami risks than those living in areas likely to be affected by a Nankai megathrust earthquake. In the Great East Japan Earthquake, however, only 57% of residents subject to evacuation orders responded quickly after the earthquake (CDPC Report 2011). A survey conducted by Weathernews Inc. (2011) that asked respondents about themselves and about friends or family members who died indicated that, only 23% of fatalities were among those who evacuated immediately after the earthquake.

On the day of the Great East Japan Earthquake, tsunami warnings accompanied by evacuation orders were issued all along the Pacific coast of central to west Japan. Ac-

cording to a survey by Kyodo News (2011), only 6% of Pacific coast residents evacuated to designated shelters on that day. The tsunami evacuation problems that emerged in the event provided important lessons for a Nankai megathrust earthquake expected areas. Thus, to investigate the details of the three above-mentioned impacts in a certain community would be very helpful for future disaster management.

3.2.2 Response to the Great East Japan Earthquake

In local communities where high tsunami is expected to come, what are the specific contents of the above mentioned three categories of impacts? How do the community residents recognize them? It is necessary to make clear about these questions and verify them through quantitative or qualitative data. In this section, I talk about these issues by using results of a questionnaire survey and my ethnographic notes collected during participation in the disaster education in Okitsu village. Before talking about the results, it is necessary to give detailed reason about why the questionnaire survey was needed in the village and its related contents of those impacts.

Firstly, I talk about the issues of individual-level topics in tsunami risk reduction. The difficulty of older people's tsunami evacuation in Okitsu can be represented by its high rate of aging population which amounts up to 48.5%. Certainly, the controversial rules of rescue activities of local volunteer firefighters under stress conditions, the suspicious effectiveness of using vehicles to evacuate also revealed as serious problems in Okitsu. All of these issues will be discussed in detail in Section 3.3.

Secondly, I talk about the challenges initiated by government reappraisals of tsunami estimation. In Okitsu, before the occurrence of the Great East Japan Earthquake, it was estimated that when an earthquake of magnitude of 8.4 on the Richter scale occurred, tsunami will arrive in the village within 18 min, and the run-up height of tsunami waves would rise up to as high as 12 m, which was published by Kochi Prefecture (2005). After the occurrence of the Great East Japan Earthquake, the possibility of a big earthquake like the Great East Japan Earthquake is discussed widely in areas where tsunami damage was expected before. For example, one of these estimates said that, when an interlocked earthquake happened due to the movement of plates along Tokai, Tonankai, and Nankai trough, its Richter scale would rise up to a magnitude of 9.0. In addition, the tsunami height would rise up to more than two to three times to the former tsunami estimates. In Kochi prefecture in particular, tsunami waves might rise up to more than 25 m. Because these information has been widely reported by newspapers (e.g. Yomiuri Shimbun 2011, 2012), they have had great impacts to community residents.

Finally, I talk about the issues of low tsunami evacuation rates in areas at high risk of tsunami damage, despite evacuation orders issued at the time of the Great East Japan Earthquake. According to archival materials of Shimanto Town (2011) in Kochi prefecture, even tsunami warnings and evacuation orders had been distributed to Okitsu on March 11, 2012, but only 26.7% of residents evacuated to shelters. This evacuation rate far exceeds the prefecture-wide average of 5.9% (Kyodo News 2011), which was likely a result of the effectiveness of advanced disaster management in the community; yet a 73% non-evacuation rate under emergency conditions is nonetheless problematic. Thus,

it is necessary to investigate residents' consciousness of disaster risk and tsunami evacuation to consider appropriate measures.

3.3 Questionnaire survey

With cooperation of the Integrated Disaster Prevention Committee in Okitsu, I conducted a questionnaire survey in January 2012. The survey focused on residents' consciousness of tsunami evacuation, with the aim of finding problems in tsunami risk reduction such as those that emerged in the Tohoku region. Distribution and collection of the survey were conducted by the Integrated Disaster Prevention Committee, who also asked cooperation of other local organizations.

Table 3.1 Outline of survey

Target	552 households
Distribution	Method: Local postal service Number: 552 packages
Collection	Period: January 10 to 25, 2012 Methods: Ten ways (Return it to students at Okitsu Elementary School or Okitsu Junior High School, <i>sodai</i> of three communities, Okitsu Elementary School, Okitsu Junior High School, Okitsu kindergarten, local assembly hall, fisher's union, local office of Japan Agriculture Cooperatives (JA), and local administrative office)

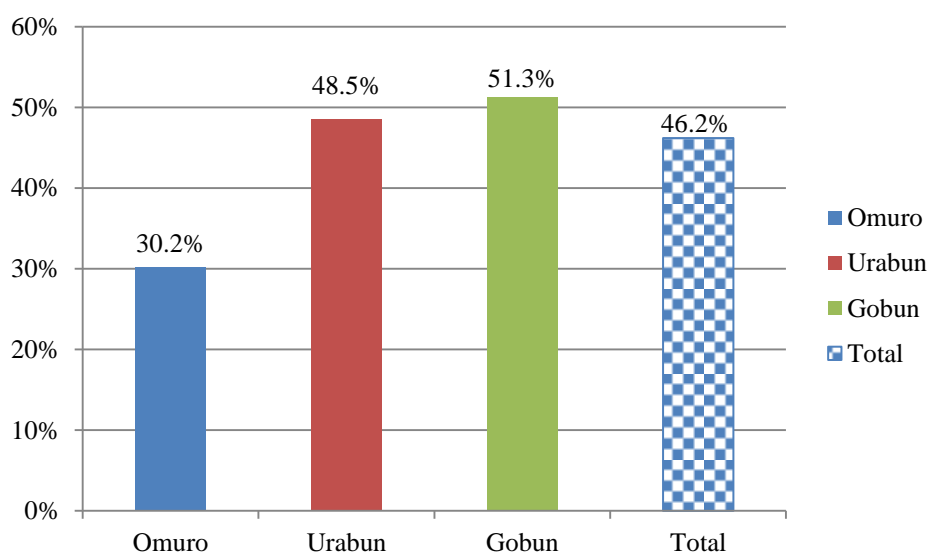


Figure 3.1 Response rate (N=225)

Table 3.1 shows the survey's outline. The survey targeted all the households in Okitsu. As of January 1, 2012, there were a total of 552 households. Specifically, there were 159 Omuro households, 198 Urabun households, and 195 Gobun households, respectively. The survey was conducted from January 10 to 25, 2012.

A total of 225 valid responses have been collected, among which the addresses of 11 respondents were unclear. It turned out that 46% were male and 54% were female. These data almost equaled to the gender ratio of the whole population. In addition, nearly 72% of the respondents are above the age of 60. Figure 3.1 shows that the average response rate is 46.2%. Omuro has the lowest rate of 30.2%. Differences seen among the response rates are described in the following contents.

3.3.1 Survey items

Table 3.2 presents items of the questionnaire survey. To make comparison with Tohoku areas about the consciousness of tsunami evacuation, it is important to discuss the concrete contents of the impacts caused by the Great East Japan Earthquake in Nankai trough areas.

Table 3.2 Survey items		
Q1	Tsunami estimates	What do you think about tsunami estimates of an expected Nankai megathrust earthquake and tsunami?
Q2	Trigger for evacuation	What would urge you to make an evacuation? (Select three from seven options.)
Q3	First-choice evacuation shelter	Which shelter would be your first-choice?
Q4	Evacuation time	How long would it take before you can evacuate to a shelter?
Q5	Evacuation methods	How would you make an evacuation?
Q6	Second-choice evacuation shelter	Which shelter would be your second-choice?
Q7	Dilemma of family members' evacuation	Would you pick up your child at school before evacuating when an earthquake occurs?
Q8	Dilemma of local volunteer firefighters' evacuation	In the event of a tsunami, do you think local volunteer firefighters should evacuate others before evacuating themselves?
Q9	Anticipated countermeasures	Which of the following tsunami management measures do you anticipate in the future? (Select three from eight options in decreasing order of importance.)
Q10	Open-ended question	Please write down any comments regarding tsunami risk reduction in Okitsu village.
Q11	Demographic items	Please write down your address, age, gender, and occupation.

Survey items were designed based on the three categorized impacts mentioned in Section 3.2. They were individual-level topics of tsunami risk reduction (Q5, Q7, and Q8), issues of tsunami estimate reappraisals (Q1 and Q9), and issues of tsunami evacuation (Q2, Q3, Q4, and Q6). In addition, an open-ended question and the demographic information of the respondents were included. I talk about the background and objectives of these items.

At the time of the survey, none reappraised tsunami predictions of a Nankai megathrust earthquake are published. However, lots of information of tsunami predictions was reported and spread in local communities, saying: “It is possible that a tsunami would occur much more serious than the previous predictions” (Yomiuri Shimbun 2011, 2012). To see what kind of influence has been exerted on community residents, Q1 asked consideration about the previous tsunami predictions.

Then, regarding the precious time period before tsunami comes, which was verified as a vital element that divided life and death in the Great East Japan Earthquake, Q2 asked triggers for evacuation and Q4 asked the time needed for evacuation. In addition, Q4 asked respondents to write down their answers instead of choosing options.

Issues of evacuation shelters and evacuation methods are definitely important for tsunami evacuation. Evidence showed that almost 23% survivors during the Great East Japan Earthquake said that their first-choice evacuation shelters were inundated by tsunami (Weathernews Inc. 2011). Based on this result, Q3 and Q6 asked people to think about several accessible evacuation shelters. Q5 asked evacuation methods which was related with the individual topics of the use of vehicles to evacuate.

Q7 and Q8 asked two dilemmas of tsunami evacuation, which related with family members and local volunteer firefighters. The dilemmas were revealed during the Great East Japan Earthquake, and urged the whole Japanese society to revisit the concept of tsunami *tendenko* (Katada 2012; Yamori 2012). In addition, Q8 also related with individual topics of local volunteer firefighters’ behaviors. The contents of Q7 and Q8 were designed in the form of the “crossroad,” which was a gaming approach to disaster education proposed by Yamori, Kikkawa, and Ajiro (2005). Q7 asked: “Suppose a big earthquake occurs while your child is at school and you are at home. The community radio announces an emergency evacuation. Would you go to pick up your child or evacuate first?” Answer: (i) I would pick up my child first; (ii) I would evacuate first. Q8 asked: “Suppose a large tsunami will arrive within 20 minutes. In this situation, what do you think local volunteer firefighters should do first: help others evacuate first, or evacuate themselves?” Answer: (i) They should help others evacuate first; (ii) They should evacuate themselves first.

Q9 directly connected with the objectives of this chapter. It asked respondents to consider what kind of problems actually exist in Okitsu village, and to think about what kind of countermeasures against tsunami disaster should be established.

3.3.2 Survey results and analysis

In this section, I summarize and analyze the survey results based on those three categories. I do not talk about the results of Q10 independently, but flexibly apply them as additional information and evidence to the results of Q1–Q9.

Individual-level topics

This subsection discusses survey results related to individual-level topics, which consist of Q5 (evacuation methods), Q7 (dilemma of family members' evacuation), and Q8 (dilemma of local volunteer firefighters' evacuation).

Responses to Q5 are shown in Figure 3.2 which indicates that more than 80% of residents would like to evacuate on foot. Note that the main Gobun shelter, the Okitsu kindergarten, is located two km from residential areas, almost 20% of residents reported they would use a car or motorcycle. Of the three communities, residents of Gobun seem to have an advantage in using motor vehicles for evacuation. Gobun is the closest area to Road No. 52 which leads to the Okitsu kindergarten and nearby towns. However, even there are traditional bamboos walls growing along the evacuation routes, there are also many narrow roads built between old brick walls that would easily collapse in a large earthquake. Using motor vehicles for evacuation requires consideration of local residents' needs, road conditions, and driving regulations in an emergency situation. This calls for special and individual approaches to community residents.

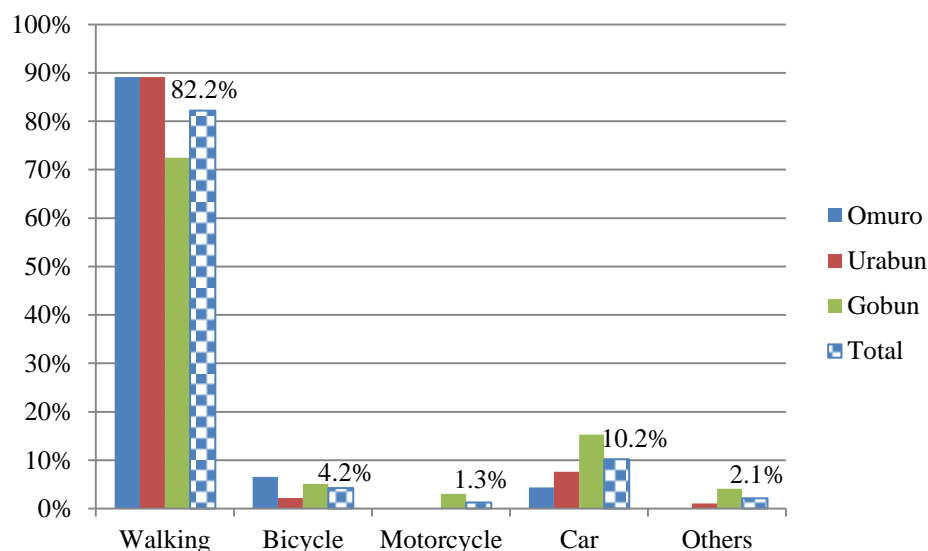


Figure 3.2 Evacuation methods (N=236)

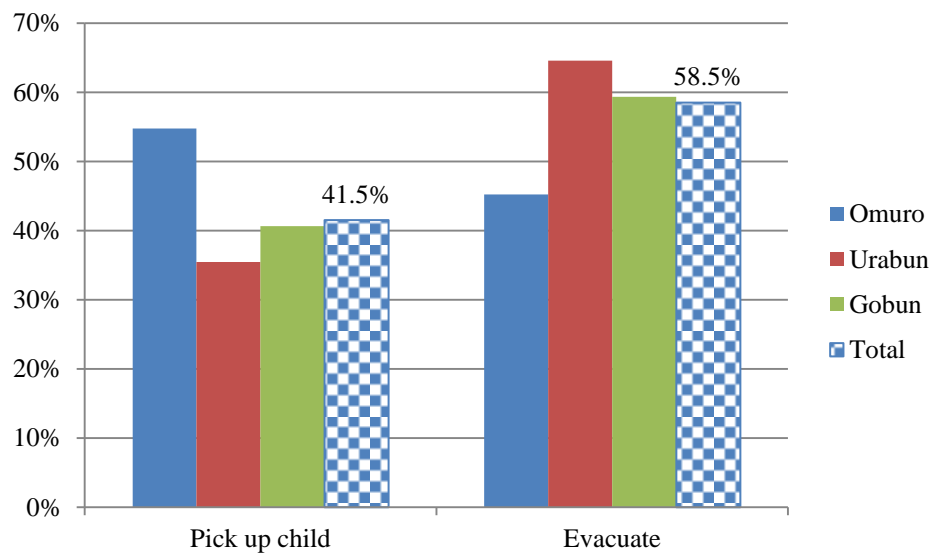


Figure 3.3 Pick up child or evacuate? (N=212)

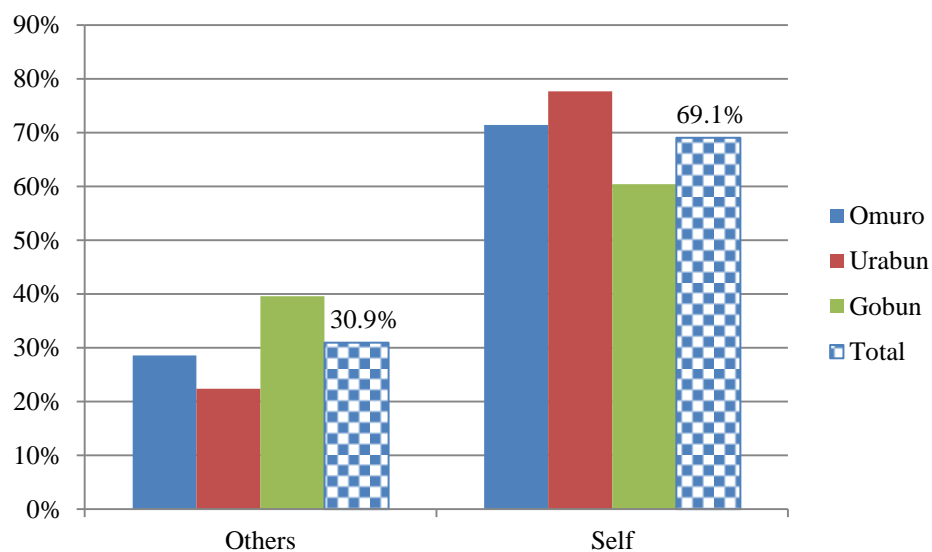


Figure 3.4 Evacuate others or self? (N=223)

Results of Q7 (dilemma of family members' evacuation) are shown in Figure 3.3. More than 40% of respondents answered that they would pick up their children before evacuating. In Omuro in particular, over 50% of residents would go to pick up children. This indicates that the importance of tsunami *tendenko* has not been completely understood and accepted in Okitsu, despite demonstration of its importance in the Great East Japan Earthquake. Moreover, as the percentage of teenagers in Okitsu is lower than 8%, but

almost 50% population is above the age of 60, the “pick up children” result could be largely based on a hypothetical child instead of a real one. From this survey result, it stands to reason that many people would similarly choose to help an elderly people to evacuate, rather than evacuate themselves first. If this is the case, the implications are serious for Okitsu. There are many reports of delayed evacuations in the Great East Japan Earthquake (Weathernews Inc. 2011; Survey Research Center 2011). In many cases, people who had evacuated to a safe location returned to a dangerous place out of concern for relatives, an act that often led to avoidable tragedy. In Okitsu, the fact that up to 40% of residents resist tsunami *tendenko* cannot be ignored.

Responses to Q8 (Figure 3.4) indicate that opinions toward local volunteer firefighters’ responsibilities during emergency conditions vary. While 70% of respondents think that local volunteer firefighters should evacuate first, more than 30% believe that they should help others first. Disaster risks in Okitsu village are such that if local volunteer firefighters took the time to assist in evacuation efforts, they would likely fail to evacuate themselves and might be engulfed by the tsunami. The problem of varied opinions on the topic of volunteer firefighters’ evacuation should thus be considered seriously.

Various opinions are also reflected in the qualitative data collected through action research. For example, one of the local volunteer firefighters told me that after the Great East Japan Earthquake, two new principles of tsunami management were notified by the local government. One is, “Do not go to close the water gate after a big earthquake.” The other is, “Support evacuation efforts only while evacuating yourself.” However, when I asked whether residents were aware of these policies, the volunteer firefighter was slightly embarrassed and replied, “They might, but I’m not sure.”

Opinions also vary in responses to the open-ended question (Q10). The opinion from a local volunteer firefighter was: “Q8 bothered me for a long time. As a local volunteer firefighter, I strongly feel that I should put others before myself. But I also know that there are circumstances where I have to protect myself first. Balancing both is difficult, so I can only hope to find the best way to protect myself and others from a tsunami.” However, one aged person responded, “I can’t imagine that local volunteer firefighters would give elderly people a hand under emergency conditions. They will only consider themselves.” To resolve this dilemma, approaches should be introduced such as investigating the distribution of local volunteer firefighters’ residences in each community to make evacuation plans that maximize the effectiveness of “Supporting evacuation efforts while evacuating oneself.”

Tsunami estimate reappraisals

This subsection describes the results of Q1 (tsunami estimates) and Q9 (anticipated countermeasures), which measure the influence of the re-evaluation of tsunami estimates of a Nankai megathrust earthquake.

Figure 3.5 shows residents’ thoughts regarding an expected Nankai megathrust earthquake. A total of 76.7% of residents answered that the scale of the resulting tsunami might exceed previous estimates. As previously noted, revised tsunami estimates had

not yet been released when this questionnaire survey was conducted, so these data demonstrate the discomposure of residents caused by the Great East Japan Earthquake. An alternative view is that residents have allowed for another “unprecedented event beyond human conception” by not completely trusting disaster experts and government agencies. Events following the Great East Japan Earthquake, such as the evacuation of school students in Kamaishi City have also reinforced suspicion against official estimates. This is because Katada , who for many years taught emergency evacuation techniques, emphasized three evacuation principles that form the core issues of disaster education. One of the three principles that facilitated the above-mentioned students’ evacuation was “*Sotei ni torawareru na*” (“Do not completely trust any kind of disaster predictions”) (Katada 2012). Therefore, it is necessary for Okitsu residents to understand the importance as well as the limitations of tsunami predictions.

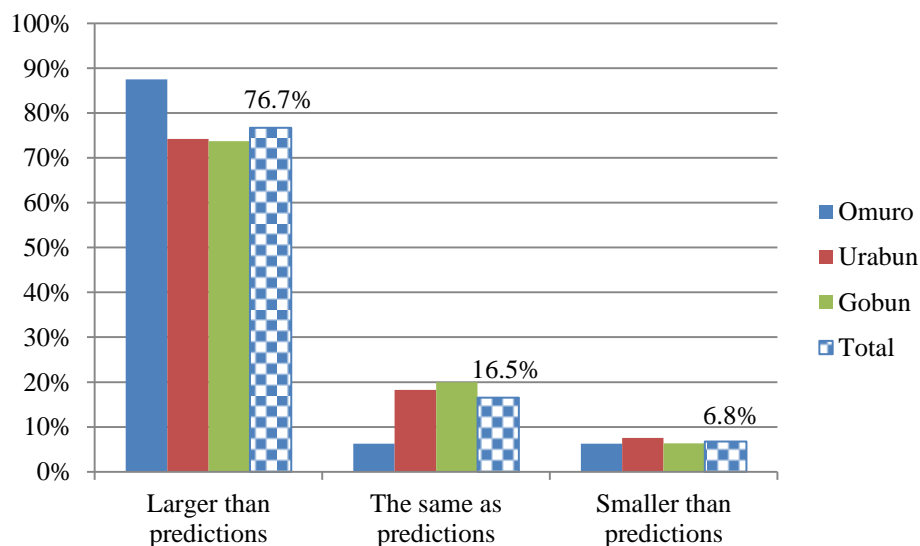


Figure 3.5 Consideration of tsunami predictions before reappraisal (N=236)

Q9 (anticipated countermeasures) asked respondents to select three out of eight options in order of importance. To focus on the most compelling needs of residents, I only discuss the results of the highest-ranked option. Figure 3.6 shows that almost 50% of residents thought that provision of shelters and evacuation roads were the most urgent aspects of tsunami management in Okitsu. As I have described in Chapter 2 that shelter capacities already exceed the whole population of Okitsu. The results of Q9 indicate that the influence of the Great East Japan Earthquake has caused significant anxiety about the re-evaluation of tsunami estimates and distrust in the safety of existing shelters, most of which are 15 m above sea level in light of the old tsunami predictions of 12 m. Opinions from the open-ended question, such as “The primary Urabun shelter seems too low when considering the inundated shelters in the Tohoku region. I hope the gov-

ernment will relocate it at least 10 m higher,” and “More evacuation routes should be constructed. Bridges leading to shelters must be repaired as soon as possible. After I heard about the horrible experiences in the Tohoku region, I keenly felt that our shelters should be re-evaluated,” verify the survey data.

However, as mentioned in Chapter 2 that several factors contributed to the extreme anxiety regarding shelters in Okitsu, including an insufficient understanding of the efforts made by Okitsu Elementary School and the Integrated Disaster Prevention Committee, as well as dependence on a number of residents who are leaders in promoting disaster prevention. Earlier, I pointed out the difference in response rates among the three communities (the rate in Omuro is much lower than the other two). One of the reasons might be the great contributions made by *osodai*, who also serves as *sodai* in Omuro. Based on my ethnographic study, I found that *osodai* does not interest in motivating other general residents to participate actively in the decision making process such as the infrastructure constructions or discussions of software countermeasures. *Osodai* usually says: “We take responsibility to make constructions, *you* only have to make evacuations.” In this way, comments seen in the results of Q10 such as “We put our trust in the Integrated Disaster Prevention Committee to do disaster prevention,” or “Members on the Integrated Disaster Prevention Committee just like to do disaster prevention in their own ways” contributed to form the dependent attitude among community residents.

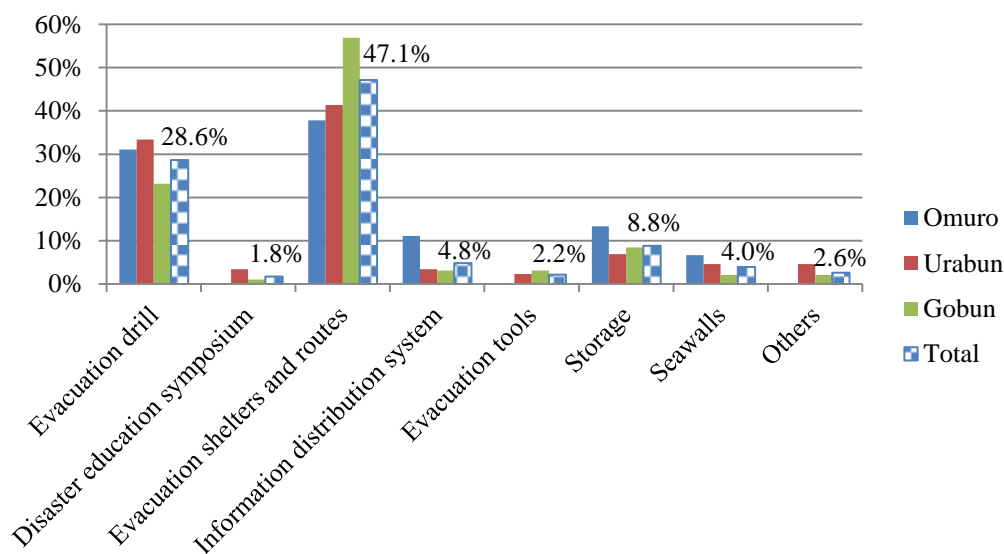


Figure 3.6 Anticipated countermeasures against tsunami disasters (N=227)

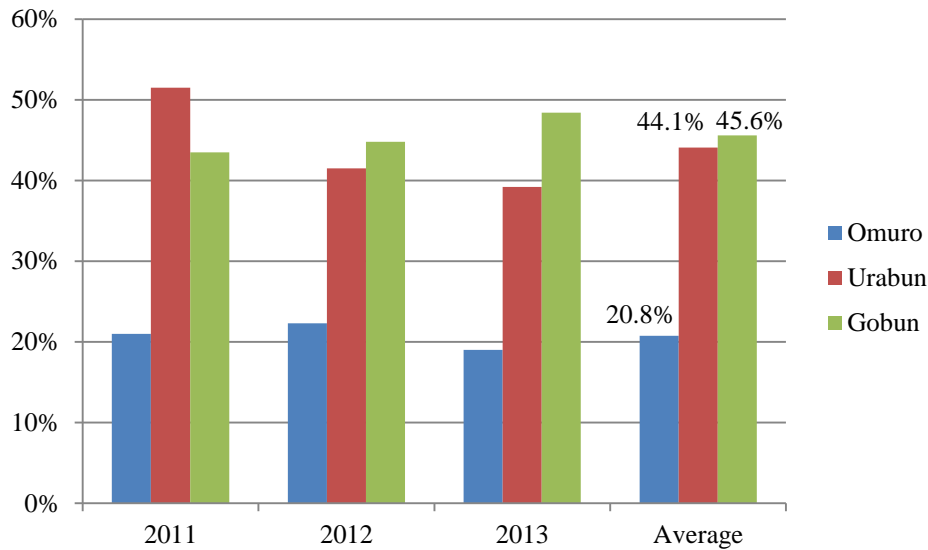


Figure 3.7 Participation rate of annual evacuation drill

Also, evidence which can give liable explanation to the gaps of response rate is the data of participation rate of annual evacuation drill over the past three years (Shimanto Town 2013). In Okitsu, the annual evacuation drill is planned by Okitsu Voluntary Organization for Disaster Prevention and usually conducted in the early September. Figure 3.7 shows the participation rates from 2011 to 2013. After the occurrence of the Great East Japan Earthquake, the participation rates turned out to be, 21.0% in Omuro, 51.5% in Urabun, and 43.5% in Gobun in 2011; 22.3% in Omuro, 41.5% in Urabun, and 44.8% in Gobun in 2012; and 19.0% in Omuro, 39.2% in Urabun, 48.4% in Gobun in 2013. Thus, the average rate in every community during the three years is, 20.8% in Omuro, 44.1% in Urabun, and 45.6% in Gobun. Here, the figure of Omuro is the lowest. (In addition, the reason why the participation rate goes downward in Urabun is that, some residents changed their first choice evacuation shelters to Mt. Mukai shelter which locates in Gobun).

The lowest figures indicate that Omuro residents do not have high interest in tsunami risk reduction. Comparing with the response rate and the participation rate in three communities, it is clear to see that the reason why Omuro residents are indifferent is exactly that, a small number of people in Omuro such as *osodai* make great contributions to tsunami risk reduction. As mentioned in Chapter 2 that, due to the polarized attitudes toward tsunami risk reduction, the relationships of participants concurrently became consolidated. Influences of the attitudes are shown on the lowest rates. Thus, for Okitsu, to overcome this serious problem, it is necessary to transform the previous approaches to disaster prevention from the whole village level to individual level. For example, one optional method is to motivate community residents to make flexible use of the evacuation shelters such as single-person drill.

Issues of tsunami evacuation

This subsection discusses issues related to tsunami evacuation, which consist of Q2 (trigger for evacuation), Q3 and Q6 (evacuation shelters), and Q4 (evacuation time).

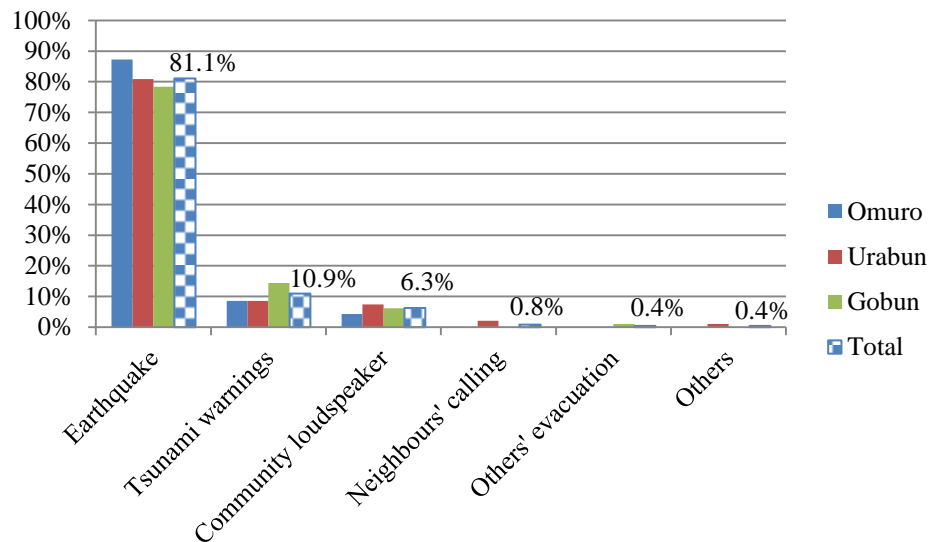


Figure 3.8 Trigger for evacuation (N=238)

In Okitsu, 81.1% of residents reported that they would evacuate quickly after a big earthquake (Figure 3.8). This is a much higher rate than the survey data regarding tsunami evacuation in the Great East Japan Earthquake, and is thus indicative of the effectiveness of disaster education in the village. Nonetheless, actual rates have not been verified in a real disaster, and reported potential actions may not translate into actual behavior.

Risks in Okitsu are such that immediate evacuation following a large-scale earthquake is vital, yet 10.9% of residents reportedly will not evacuate without hearing an evacuation recommendation or order. Worse yet, 6.3% of residents would wait to hear such information on the community loudspeakers. It is rational to want to collect information regarding earthquake and tsunami, but waiting for more information in lieu of making a quick evacuation (Katada, Kodama, Kuwasawa, and Koshimura 2005; Yamori 2013) would be a serious problem in Okitsu.

I posed Q3 (first-choice evacuation shelter) and Q6 (second-choice evacuation shelter) because 23% of Tohoku survivors reported that the first place they evacuated to was inundated by the tsunami (Weathernews Inc. 2011). Figure 2.2 and Figure 3.9 indicate that most residents selected shelters in their own residential areas (“other” always indicates high ground near respondents’ houses). In particular, 80% of Omuro residents se-

lected the primary Chureito shelter or Omuro Honmura shelter. More than 70% of Gobun residents selected the Okitsu kindergarten. More than 70% of Urabun residents selected Saihoji shelter or the Todaiguchi shelter. Because of the location and the balanced construction of shelters in the three communities, most residents know exactly where to evacuate to, which deserves high praise.

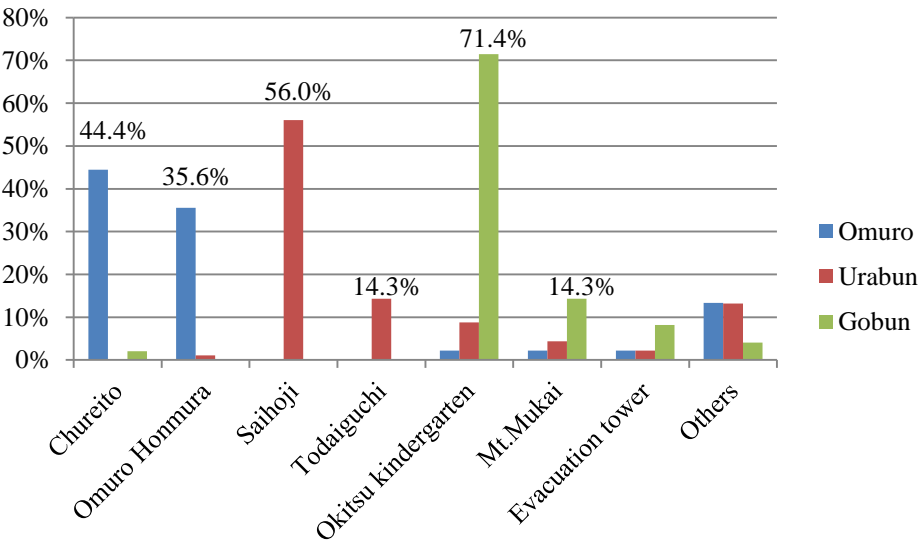


Figure 3.9 First-choice evacuation shelter (N=234)

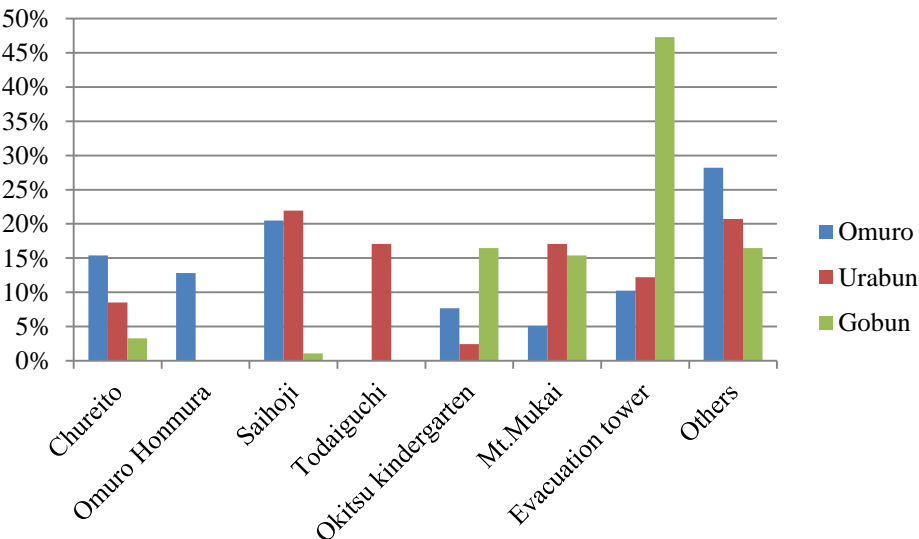


Figure 3.10 Second-choice evacuation shelter (N=212)

As shown in Figure 2.2, sufficient evacuation shelters in Okitsu were constructed according to the residential conditions and the population in each community. However, people would probably not be at home, or evacuation routes leading to their first-choice evacuation shelters would be blocked by collapsed walls. So, it is important for residents to be familiar with more than one shelter to ensure successful escape from a tsunami. Figure 3.10 shows various ways to deal with inaccessibility to residents' first-choice evacuation shelters. Almost 50% of residents selected evacuation towers at 15 m above sea level, or "others" (high ground near their houses). This indicates that even evacuation towers cannot enable people to evacuate to a higher place, but can serve as a secondary evacuation shelter when a tsunami is actually flooding in. That is to say, towers are subordinate methods of tsunami evacuation. Local residents considered more available shelters besides the designated ones, which was admirable. Moreover, responses to the open-ended question, such as "Evacuation shelters cannot fit everyone's need. More evacuation routes should be constructed to allow quick evacuation to high ground," indicate a proactive attitude. Nonetheless, from the perspective of safety, it is necessary to test whether non-designated places could be used as shelters.

Finally, I discuss the results of Q4 (evacuation time). A tsunami is expected to hit Okitsu soon after an earthquake, so the time required to evacuate to shelters is one of the most important issues in tsunami risk reduction. Q4 asked respondents to guess their estimated evacuation time, rather than selecting options. When the survey was conducted in Okitsu, there were no official reports on tsunami estimate reappraisals, but lots of information released on TV and newspapers suggest that a ferocious tsunami would come even within 3 minutes. Considering the then-current disaster estimates that a tsunami would arrive within 18 minutes, even several seconds of evacuation time would be a matter of life or death. So, I classified the results of Q4 into five categories, which are 0-3 minutes, 3.1-5 minutes, 5.1-10 minutes, 10.1-18 minutes, and over 18 minutes, though unevenly.

Figure 3.11 shows that almost 90% of residents said they could make a successful evacuation within 18 minutes, and nearly 30% answered that they could evacuate within five minutes. Meanwhile, the results of each community show that residents living in Gobun require more time than the other two, with 18.4% of residents requiring more than 18 minutes. This is likely because the Okitsu kindergarten is somewhat far from residential areas.

According to survey reports, residents in the Tohoku region spent almost 30 minutes to evacuate to shelters, including the time period before and during evacuation (Ministry of Land, Infrastructure, Transport and Tourism 2011). Thus, it is very likely that the Okitsu data underestimate the required evacuation time, because it was a predicted one. Tsunami evacuation time is important for Okitsu and other coastal regions, so finding out what elements determine it is important.

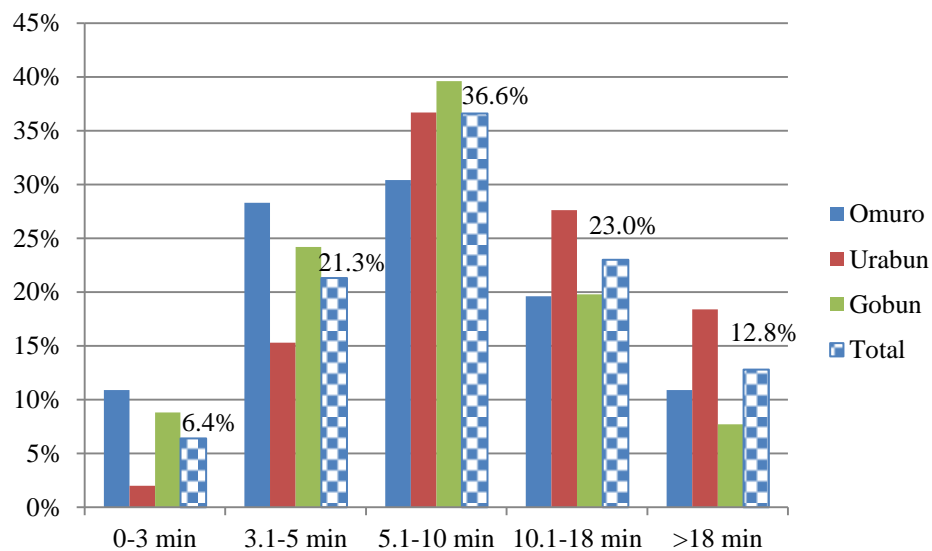


Figure 3.11 Predicted evacuation time

Evacuation time

To further discuss the evacuation time, I set Q4 as the explained variable and all the other questions except the open-ended question as explanatory variables, and applied CATDAP, a categorical data analysis program package for analyzing cross-classified data. CATDAP automates the search for optimal combinations of predictors (explanatory variables) on which a specific response variable (the explained variable) has the strongest dependence.

Specifically, CATDAP calculates Akaike's information criterion (AIC), which ranges from small to large order in the form of cross-classified data on explanatory variables (Sakamoto 1985). Recognition as a significant category of data occurs when AIC is less than -1 (Terado *et al.* 2004). If the explanatory variables have more than three items or if they are continuous, CATDAP will auto-categorize them into groups giving the smallest AIC. For example, the items "strongly agree, agree, disagree, and strongly disagree" might be categorized into two groups, such as one group of "strongly agree" and the other of "agree, disagree, and strongly disagree."

Table 3.3 shows the top fifth AIC values, ranked from low to high scores of explanatory variables when Q4 is the explained variable. The corresponding cross-classified data are shown in Tables 3.4 to 3.7. Because I have discussed the relationship between A (address) and Q4 (evacuation time), here, I limit the discussion to other items, namely, shelter (Okitsu kindergarten and others), gender, trigger for evacuation (earthquake and others), and anticipated countermeasure against tsunami disaster (evacuation drill and others).

Table 3.3 Intimate relationships between evacuation time and other items

Rank	Explanatory variables	Number of categories of exp. var.	AIC
1	Q3 (First-choice evacuation shelter)	2	-15.61
2	G (Gender)	2	-7.02
3	A (Address)	2	-6.24
4	Q2 (Trigger for evacuation)	2	-5.42
5	Q9 (Anticipated countermeasures)	2	-3.25

Table 3.4 Cross tables of evacuation time (Q4) and first-choice evacuation shelter (Q3)

Q3 / Q4	0-3 min	3.1-5 min	5.1-10 min	10.1-18 min	>18 min	Total	Significant figures
Kindergarten	0.0%	15.1%	33.7%	28.7%	22.5%	100%	80
Others	7.7%	23.8%	43.1%	20.0%	5.4%	100%	130

Table 3.5 Cross tables of evacuation time (Q4) and gender (G)

G / Q4	0-3 min	3.1-5 min	5.1-10 min	10.1-18 min	>18 min	Total	Significant figures
Male	12.1%	22.4%	39.3%	17.8%	8.4%	100%	107
Female	1.7%	21.5%	35.5%	24.8%	16.5%	100%	121

Table 3.6 Cross tables of evacuation time (Q4) and trigger for evacuation (Q2)

Q2 / Q4	0-3 min	3.1-5 min	5.1-10 min	10.1-18 min	>18 min	Total	Significant figures
Earthquake	7.4%	21.6%	40.6%	21.1%	9.3%	100%	204
Others	0.0%	22.9%	20.0%	31.4%	25.7%	100%	35

Table 3.7 Cross tables of evacuation time (Q4) and anticipated countermeasures (Q9)

Q9 / Q4	0-3 min	3.1-5 min	5.1-10 min	10.1-18 min	>18 min	Total	Significant figures
Evacuation drill	10.1%	20.9%	36.5%	17.8%	14.7%	100%	129
Others	1.9%	25.0%	37.0%	26.8%	9.3%	100%	108

To begin with, I discuss the relationship between tsunami evacuation time and evacuation shelters shown in Table 3.4. The auto-categorized results for evacuation shelters are grouped into Okitsu kindergarten and others, where “others” indicate all the other shel-

ters (Figure 2.2). This result can be explained that the location of Okitsu kindergarten is far from the residential areas.

Next, I discuss the relationships between tsunami evacuation time and gender. Since the questionnaire survey packages were allocated to every household but not the individuals, a gender bias of respondents can be considered. Nonetheless, the gender ratio of respondents (46% male to 54% female) is pretty close to that of the whole population (47% to 53%), which indicates that the result of the questionnaire survey best represents the gender characteristics in Okitsu. Table 3.5 shows that 12.1% of males suppose that they can evacuate within 3 minutes, compared to only 1.7% of females. Twice as many women as men claim they need more than 10 minutes to evacuate.

It is difficult to explain the difference using only the survey results, so I suggest the following as possible reasons. Generally, compared with men, women usually have less physical strength and lower coping capacity under emergency situations. Also, in most cases, the behavior of women is determined by extrinsic factors, for example, in the collection of disaster information or decision-making. When I discussed this issue with residents in Okitsu, one female said, “When I go out without taking the bankbook with me, I’m anxious about the future livelihood of my family should an earthquake strike.” This indicates that different expected actions between men and women might lead to delayed evacuation among women.

Table 3.6 shows the relationships between expected tsunami evacuation time and reason for evacuating. The term “others” include tsunami warning, community loudspeakers, neighbors calling, others evacuating, tsunami, and other factors except the earthquake. I find that people who claim they can evacuate within three min all considered evacuating immediately after an earthquake. In contrast, 26.8% of residents who need more than 18 minutes will not evacuate even after a big earthquake (in fact, they decide to evacuate because of other motivations).

In those areas where a tsunami will hit shortly after an expected Nankai trough earthquake strikes (such as Okitsu), reducing the number of casualties requires that residents take earthquake tremors as the sign to evacuate. Some Okitsu residents told me that they remembered the Showa Nankai Earthquake in 1946 and learned the importance of quick evacuation after an earthquake strikes. One respondent said, “I keep my purse near my pillow in case an earthquake occurs in the night.” Such valuable experiences of residents should be taken seriously and spread to the population at large.

Finally, I discuss the relationships between tsunami evacuation time and anticipated tsunami prevention countermeasures (Table 3.7). Here, the term “others” include measures such as disaster education symposiums, constructions of evacuation facilities, establishment of information distribution system, preparation of evacuation tools and storage, and upgrade to sea levees. It is interesting that both those who claim to have the capacity to successfully evacuate within three min and those who would require more than 18 minutes insist that evacuation drills are important. This tendency might be explained in that people who can evacuate quickly realize the function and achievements of evacuation drills and thus praise them, while people who suppose they need more

time to evacuate intend to participate in evacuation drills to enhance their evacuation capabilities. Nevertheless, people who require 3 to 18 minutes to evacuate emphasize the importance of other aspects of tsunami risk reduction. Thus, it is necessary to introduce more appropriate approaches based on the various individual needs, according to their predicted evacuation time.

3.4 Conclusion

This chapter discussed the results of a questionnaire survey conducted in Okitsu village, where advanced disaster education has been effectively promoted in light of the high risks of a previously expected Nankai earthquake. Considering the impact of the Great East Japan Earthquake, I investigated issues concerning tsunami evacuation, such as individual-level topics, reevaluation of tsunami estimates, and issues of tsunami evacuation in detail. In Okitsu, not only has infrastructure been established, but also software strategies such as disaster education have also been carried out. These achievements were verified by the results of the questionnaire survey.

However, as discussed in the above contents, lots of problems still exist in tsunami risk reduction. For example, according to the survey results, there were strong dependency on a small part of community residents and local government, difficulties of older people's evacuation, advantage and disadvantage of using vehicles to evacuate, and negative attitudes toward the evacuation wisdom of tsunami *tendenko*. To resolve these problems, I have pointed out that it is necessary to take the situation of individual residents into consideration to plan concrete measures. As further analyzed by using the CATDAP method, differences in community residents such as predicted evacuation time, evacuation motivation and attitudes are all rooted in the individual-level issues and specific needs.

As researchers conducting action research in the Okitsu village, I cooperate with Okitsu Elementary School, the Integrated Disaster Prevention Committee, and the local government to promote a new approach called the single-person drill. Detailed information will be provided in Chapter 4. What I emphasize here instead is that since the questionnaire survey was conducted through action research, it not only pointed out problems and analyzed past achievements, but also served to find further solutions. This is the essential meaning of doing action research. Thus, I want to briefly describe what the practical meaning of the single-person drill is to show the long-term objectives of the study.

The single-person drill aims at overcoming the difficulties described in this chapter, by shifting tsunami risk reduction from a general, non-urgent condition to a specific, concrete task that can be accomplished by an individual resident. For example, not only the construction of infrastructure is important, but also the relationships between community residents and the infrastructure should be paid attention to. In this way, it is possible to discuss the concrete and personal issues of tsunami evacuation and to enhance the residents' consciousness of disaster risk, which can eventually make contributions to the actual practice.

As the need for tsunami risk reduction of an expected Nankai megathrust earthquake increases, core issues of damage mitigation and coping capacities based on special and individual conditions are indispensable. The discussions in this chapter are exactly an initial step toward meeting the requirement for action research. So, the study does not just retain the position of finding out problems, but pursues betterment for the local community.

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Chapter 4

New approaches to tsunami risk reduction: Promoting disaster education and evacuation drills

4.1 Introduction

This chapter talks about negative effects of the reappraised estimates of a Nankai megathrust earthquake and tsunami on community residents and the configuration of tsunami risk reduction.

In the latter half of Chapter 2 and the whole of Chapter 3, I discussed the tremendous impacts caused by the Great East Japan Earthquake. I presented the specific details of these impacts based on information collected through my ethnographic study in Okitsu village. I described the detailed contents of disaster education and the attitudes of community residents toward tsunami risk reduction. Results showed that markedly different social situations and subsequent requirements appeared in tsunami risk reduction in Okitsu before and after the occurrence of the Great East Japan Earthquake. One serious problem that emerged is polarization of community resident's attitude and subsequent behavior toward tsunami risk reduction. That is, some residents serving as community leaders are greatly concerned about tsunami risk reduction but the other residents, mainly older people, have less interest.

To overcome this problem, I mentioned in Chapter 2 the importance of introducing a new approach to transforming negative attitudes into positive ones. Former approaches to tsunami risk reduction in Okitsu focused on the whole community level, so I suggested a new approach called the single-person drill, which focuses on individual activities. To apply this approach to tsunami risk reduction in the community, it is necessary to enhance collaboration between disaster experts and community residents, because results of this approach must be strictly verified by using professional technology.

This chapter is mainly dedicated to describing the process of the single-person drill, a form of action research conducted by researchers (research experts) and co-researchers (practice experts). In addition, as a collaborative participant in the action research I played the role of both community resident and researcher. In this chapter, I report on the specific content of the action research by presenting its implementation process, contributions made by each participant, and the production process of multi-screen movies as research output. On the basis of this content, I analyze the essential meaning of continuous tsunami risk reduction, the formation and transformation of communities of practice, and the identities of its participants. I also discuss the importance of dialogue between researchers and co-researchers, and dialogue between the natural and human sciences.

The arrangement of this chapter is as follows: Section 4.2 discusses the characteristics of tsunami estimates based on the characteristics of risks. Drawing on previous studies

on tsunami risk reduction and the present social situation in local communities, I explain why personal approaches are urgently needed. Then, Sections 4.3 and 4.4 give detailed information of the implementation process and subsequent results of the single-person drill. Section 4.5 discusses theoretical considerations from the perspective of communities of practice, and Section 4.6 analyzes the essential meaning of action research in tsunami risk reduction.

4.2 Tsunami estimates

Due to the enormous impacts exerted by the Great East Japan Earthquake, residents of areas where a Nankai megathrust earthquake is expected to cause serious tsunami damage became suspect of previous tsunami predictions and the effectiveness of infrastructure. The Cabinet Office put great effort into reappraising disaster estimates, and published a series of estimates of disaster scale, building damage, and human casualties. The most serious disaster projection in the latest report (Cabinet Office 2013) is that an earthquake with intensity 7 on the Japan Meteorological Agency's scale will strike and affect many coastal areas. This will result in a tsunami exceeding 30 m hitting residential areas across a wide range, destroying some areas. Flooding, building collapse, and fires may cause as many as 323,000 deaths. Under this prediction, important research questions include the following: Facing such grave estimates, how do community residents react? What do they think about previous disaster countermeasures? What do they plan to do to reduce tsunami risk in the future?

4.2.1 Characteristics of disaster predictions

There are two facets to the predictions of a Nankai megathrust earthquake: the objective matter of damage due to natural disaster, and the variable matter of how human society is affected by such damage.

Regarding the former, predictions are usually stated as something like, "It is supposed that an earthquake with an intensity of 7 on the Japan Meteorological Agency's scale will occur, and a tsunami with waves exceeding 30 m will arrive." Such statements have no influence on the occurrence of a natural disaster. Natural disasters have their own characteristics of motion, independent of human activities. For example, the movement of tectonic plates or the sea will not change due to the reappraisal of predictions. In this sense, such predictions describe the "objective danger" of a natural phenomenon or its results on human society. Thus, this prediction type has the characteristics of "a neutral danger" (Yamori, Kikkawa, and Ajiro 2005: 2-8).

Regarding the latter, predictions are usually presented as something like, "The most serious estimations predict as many as 323,000 deaths." Such statements do influence the actual results of damage, because damage varies according to societal preparation. If more people have negative attitudes toward tsunami risk reduction after hearing such predictions, damage could grow to exceed even the direst predictions. To some extent, such predictions depend on the decision-making and behavior of humans, and thus they have the characteristics of "an active risk" (Yamori *et al.* 2005: 2-8).

Examples of efforts toward changing the second prediction type have been seen in some municipalities, which include development of new countermeasures against tsunami risk reduction, and initiatives taken in motivating community residents to take part in tsunami risk reduction. Specifically, in Kochi prefecture government agencies published a third prediction type, which describes the potentialities to change the second prediction type. Another example of the second prediction type might be written as, “According to the current situation, if the rate of earthquake-proof houses is 74%, and the rate of immediate tsunami evacuation is 20%, meaning that 20% of residents immediately evacuate after an earthquake, then there will be almost 42,000 deaths.” In contrast, the third prediction type might say, “If the above-mentioned rates were both improved to 100%, then, deaths due to building collapse and fire will be reduced to one-tenth of the worst-case prediction, and tsunami deaths will be reduced to one-sixth” (Kochi Prefecture 2013).

The first and second prediction types are interrelated. Releasing estimates of a neutral danger to the general public would probably cause an active risk. Similarly, when faced with an active risk, people likely require more detailed and accurate predictions of the neutral danger. Nonetheless, in areas where serious damage is expected, some community residents treat the second prediction type as a neutral danger. This is one reason for increased negative attitudes toward tsunami risk reduction. In the following subsection, negative attitudes are divided into three types, based on news reports, statistical survey data, and my ethnographic study.

4.2.2 Three types of negative attitudes

Three types of negative attitudes have been seen in community residents after the release of the reappraisal results of tsunami predictions. The first negative attitude can be described as “overly pessimistic” to tsunami risk reduction. After a report by the Cabinet Office (2012), I heard many negative comments on tsunami risk reduction in local communities. For example, “*They* say a giant tsunami will arrive here. If it really comes, can’t we just sit on top of the highest nearby mountain and cast our fishing lines into the tsunami? I will not make any further effort to prepare for the tsunami according to *their* predictions.” I also heard comments by elderly persons such as “When the tsunami really comes, I would like to be swept away with my house.”

Statistical evidence can be seen in the report of Nakamura *et al.* (2013). They conducted a survey in Shimoda and Kuroshio, both located in Kochi prefecture, where the highest tsunami over 34 m is expected to arrive. Because the whole population of both areas would be affected by a tsunami, Nakamura *et al.* randomly selected 120 adults as informants. Results of the survey show that 10.8% of respondents (6.7% in Shimoda and 15.0% in Kuroshio) answered “Because predictions are so serious, I’ve started to believe it is meaningless to further prepare for tsunami risk reduction.”

The second negative attitude can be described as “overly optimistic” regarding tsunami risk reduction. When I interviewed residents about their opinions of the serious predictions, some people said things like “I do not think a tsunami will come during my lifetime,” “It does not make sense to think so seriously about the tsunami. What will be,

will be,” and “I think that such predictions of earthquakes and tsunamis are unnecessarily disturbing news to our general community residents.” Similar opinions have also been seen in newspapers, such as “I have been told that tsunamis would come ever since I was a little child. Whatever happens, happens” (Mainichi Shimbun 2012).

The third negative attitude can be described as “overly dependent” to tsunami risk reduction. Comments related with this kind of attitude are represented by “There’s nothing can I do about the predictions. I surrender. I hope that disaster experts and government agencies will give us a hand.” Similar comments are presented in the results of the questionnaire survey in Chapter 3. Those comments indicated a strong dependency on disaster experts and government agencies. For example, “I hope that safe evacuation shelters located at higher places will be constructed as soon as possible,” “I hope that routes to evacuation shelters and bridges on the routes will be upgraded to withstand earthquakes as soon as possible,” and “I hope that evacuation routes will be widened.”

These three types of negative attitudes are interrelated. From the perspective of human psychological dispositions, Yamori (2013) argues that “When people are faced with titanic peril, they either become desperate or inclined to belittle the peril.” This indicates that overly pessimistic and overly optimistic attitudes are two sides of the same coin. Furthermore, as overly pessimistic attitudes guide people to give up on taking action, and overly optimistic attitudes make people belittle taking action, overly dependent attitudes are thus easily formed. The eventual result is relying on experts and government agencies.

Disaster predictions must be calculated based on professional knowledge, and thus in general can be produced by only disaster experts and government agencies. However, there are two types of messages in the disaster predictions. One is the literal message of disaster predictions. The other is a meta-message implied by the disaster prediction. For example, a literal message says, “A tsunami has been observed. Please evacuate to higher places immediately.” The implied meta-message is that “People like *us* produce and provide the predictions, and people like *you* receive those predictions and follow them to take action.” Thus, if there are overly adversarial or overly dependent relationships between community residents and disaster experts or government agencies, disaster predictions will be presented as a neutral danger.

From the above discussion, it is clear to see that the problem of communication as one-way transfer that emerged during the Great Hanshin–Awaji Earthquake still existed at the time of the reappraised predictions for a Nankai megathrust earthquake. To cope with this problem, it is necessary to establish a method of “communication for mutual consensus-making.” Specifically, disaster experts must transform their position from knowing risk and calculating neutral danger, to serving as partners who collaborate with community residents by sharing active risk. Community residents in turn must transform their attitudes toward disaster predictions, from only considering predictions as an unchangeable neutral danger to proactively taking part in reducing active risk (Yamori *et al.* 2005). Thus, in this chapter, I propose that communication for mutual consensus-making between researchers and co-researchers is an action research. Specific con-

tents of the action research are presented based on my ethnographic study in the following sections.

4.2.3 Previous studies on tsunami evacuation behavior

In this section, I talk about previous studies on tsunami evacuation behavior, based on which I show the methodology and research direction of this study. In Section 1.2 I summarized previous studies on tsunami evacuation that examined the behavior of either individuals or groups, but here I clarify the differences between previous studies and this study.

Studies on tsunami evacuation pay extraordinary attention to understanding the eventual results instead of the complicated process of human behavior. For example, there are studies that develop models of tsunami evacuation (Imamura, Suzuki, and Taniguchi 2001), studies that make hazard maps based on the results of collaboration between community residents and disaster experts (Toyoda and Kanegae 2012), and studies that develop tsunami simulators to visualize the results of human behavior and property damage in an entire region (Katada and Kuwasawa 2006). With hazard maps or simulators, community residents can easily understand the overall situation of tsunami disasters such as dangerous places in the region and evacuation results, so these studies can potentially motivate disaster awareness in community residents. However, in these studies various parameters or disaster scenarios are given by researchers in advance. Though they can present the whole situation in an entire region, they cannot describe the concrete and complicated process or results of tsunami evacuation by individuals.

To cope with this shortcoming, Katada, Kanai, Hosoi, and Kuwasawa (2011) suggest a new type of tsunami simulator. They define parameter categories in advance, but the data for each parameter are given directly by individual participants. For example, they ask each participant about the evacuation start time or place and evacuation routes, and directly input answers into the simulator. Each result is thus calculated by the simulator in a manner highly similar to the actual situation of each participant. However, this method has potential to promote tsunami awareness among only participants with high interest in tsunami risk reduction, and cannot resolve the problem of how to change the attitudes of those who are reluctant to take part in tsunami risk reduction. Furthermore, because participants provide the parameters used in the simulator, they represent intent rather than action in an actual evacuation.

Considering these shortcomings of studies and practice of tsunami risk reduction, I intend to clarify concrete processes such as the time needed for evacuation, evacuation methods and routes, shelter utilization, and the effects of mutual help. This study attempts to suggest appropriate methods for overcoming negative pessimistic, optimistic, and dependent attitudes through action research.

Specifically, drawing on the traditional approaches to disaster education and tsunami evacuation that have been thoroughly developed in the field of disaster prevention, I suggest a new approach called the single-person drill. Results of the single-person drill are edited into multi-screen movies based on collaboration among tsunami experts who

study the mechanisms of tsunami occurrence, computer graphics experts who make videos for TV broadcasting, and researchers who study human behavior and psychology.

4.3 The single-person drill

As part of a long-term ethnographic study in Okitsu, I collaborated with the Okitsu Elementary School in developing the single-person drill. I served as a coordinator to some extent, for example by motivating people to participate in the drill, visiting community residents' homes, taking part in village events, and studying with students in disaster education classes.

I have described how Okitsu urgently needs an improved approach to tsunami risk reduction. According to the latest estimates by Kochi Prefecture (2012), a Nankai megathrust earthquake is expected to generate a huge tsunami that will severely damage the village. In addition, as mentioned in Section 4.2, the reappraisal of tsunami predictions has resulted in three negative attitudes among community residents. To cope with these problems, I argued in Chapter 2 that it is necessary to transform the approach to tsunami risk reduction from a community-level approach to an individual-level one. In Chapter 3 I also argued that it is important to analyze the concrete process of tsunami evacuation of each individual. In this chapter, I propose that communication for mutual consensus making between researchers and co-researchers is required. The single-person drill is a result of such discussions.

The single-person drill is expected to overcome the limitations revealed over the plateau period. Specifically, the polarized attitude between those who are very interested in disaster prevention and those who are indifferent is expected to be transformed into a collaborative practice of disaster prevention. In this sense, disaster prevention in Okitsu has reached a fourth period, a "period of transformation."

4.3.1 Outline of the single-person drill

During a single-person drill a single evacuee, typically an elderly person with a piece of global positioning system (GPS) device, heads from home to a designated evacuation shelter. A group of school students record the drill process as a lesson regarding disaster education. All the records of the drill are summarized into multi-screen movies, which are collaboratively made by school students, tsunami experts, CG experts, and other researchers. The movies are used as disaster education tools at Disaster Education Symposium held by the Okitsu Elementary School. Participants include students, evacuees, community residents, government officers, researchers, and journalists.

Photo 4.1 shows tools used in the single-person drill: two video cameras, one stopwatch, and one piece of GPS device. During the drill, five students make up one group to support a single evacuee. Two students serve as video recorders A and B. The other three students serve as time recorders, interviewers, and note takers (Photo 4.2). The students are called drill supporters. Fourteen fifth- and sixth-grade students at Okitsu Elementary

School were divided into three drill supporter groups, named the Omuro Group, the Urabun Group, and the Gobun Group.



Photo 4.1 Tools used in single-person drills



Photo 4.2 Performing a single-person drill

4.3.2 Implementation

There are four steps to the single-person drill. The first is a brief introduction, which confirms issues such as where the evacuee will take shelter during an earthquake, whether the evacuee should take an emergency kit, and which routes and shelters will be used. We also explain the three remaining drill steps. After confirmation, the evacuee receives GPS device for recording the evacuation route taken.

The second step is a short interview. The interviewer asks for information such as the evacuee's name, age, hobbies, and considerations for tsunami risk reduction. This allows the evacuee and supporters to become somewhat familiar with each other before the actual evacuation.

The third step is a simulated evacuation. The time recorder says "earthquake" to announce the occurrence of an earthquake and the start of the evacuation. For the first 100 seconds, it is supposed that movement is impossible due to strong tremors. During this time the evacuee takes shelter under a table or other stable furniture. After 100 seconds the time recorder announces a second message, "The earthquake is over. Evacuate immediately," and the evacuee leaves home. Some evacuees take emergency kits containing items such as food, water, and flashlights.

During the evacuation, video recorder A stays close enough to the evacuee to capture facial expressions, while video recorder B maintains a certain distance to capture the surrounding situation. The time recorder uses a stopwatch to record times required to reach significant locations, which are logged on a worksheet with "where" and "when" columns. For example, the time recorder might write "police station: 3 min 43 s," "intersection: 4 min 1 s," or "telegraph pole: 5 min 20 s." The interviewer walks alongside the evacuee, asking occasional questions such as "Can you evacuate if this bridge collapses during an earthquake?" "What do you think of the hand rails along this steep path?" and "How are you feeling at this moment?"

The note taker also observes the surrounding situation, and writes down information related to the drill. Example notes might be "The evacuee looks very tired now," "I think this is a dangerous place because the surrounding clay tiles may collapse," or "On a rainy day, it is better to wear comfortable shoes that won't slip." When the evacuee arrives at an evacuation shelter, the time recorder announces, "Arrival at destination," and all the recording devices are turned off.

The fourth step is an interview survey. The evacuee and supporters retrace the route taken to check for dangerous places along the evacuation routes. When they return to the point of departure, the single-person drill is complete.

4.3.3 Products: Multi-screen movies

Recorded results of the single-person drill are summarized into multi-screen movies by a collaboration of students, tsunami experts, CG experts, and other researchers through three editing processes.

Photo 4.3 shows images from a created movie. Panels in the upper left and bottom right are camera stills shot from two angles. The upper-right panel shows two kinds of messages; messages from the evacuee are placed above those by students. The bottom-left panel shows GPS tracking information overlaid on a geographic information system (GIS) map that is part of a computer animation of a simulated tsunami. On the GIS map, a dot represents the evacuee's location during the drill, and a red line shows the evacuation route. A timer at the center of the movie presents the elapsed time during the drill. The contents of the four panels are displayed in synchronization with the timer. Detailed information of the editing processes is described below.

The first editing process

During the first editing process, tsunami experts collaborate with CG experts to create the content for the panels in the upper left (close-up video recordings by camera A), bottom right (medium-distance recordings by camera B), and bottom left (GPS data overlaid on a GIS map). Tsunami experts run a tsunami simulation to calculate the movement of a tsunami in Okitsu based on the worst-case scenario published by the Cabinet Office. CG experts transform the results of the tsunami simulation into a computer graphics animation. The animation is overlaid with the GPS data, and superimposed on the GIS map in the bottom-left panel. Then, the timer is placed at the center of the movies. This allows community residents to easily visualize the overall situation of the single-person drill. For example, it is very easy to grasp how long it takes evacuees to arrive at a bridge, or where the first place to be inundated by a tsunami will be.



Photo 4.3 Screenshot from a multi-screen movie (Production: Yamori Laboratory of Disaster Prevention Research Institute, Kyoto University; Tanista; Osaka Station, Japan Broadcasting Corporation)

The second editing process

During the second editing process, CG experts and I collaborate to place messages from the evacuee in the upper-right panel of the movies. Notes recorded by the note taker and the interviewer are both used. The message format, suggested by the CG experts, stipulates that single messages are limited to two rows, with no more than 10 Japanese characters in one row. This allows timely presentation of message content, and furthermore motivates viewer consciousness of the tsunami disaster and encourages students to give more suggestions regarding tsunami risk reduction. Examples of editing such messages are as follows:

Evacuee: “I’m not afraid to go through tunnels on evacuation routes when I’m running to the evacuation shelter as fast as I can” → “Don’t be afraid, just keep running”

Evacuee: “This road seems too narrow for three people to pass at one time. When an earthquake occurs, this might cause a bottleneck” → “Walk in a single file on narrow roads”

The third editing process

During the third editing process students, CG experts, and I work together to edit messages from students and add them to the upper-right panel. Student supporters of the single-person drill greatly contribute to this editing. Using the unfinished movies, they carefully review their supporting activities and respond to evacuee messages by giving opinions on evacuee behavior and tsunami risk reduction in Okitsu. For example, they give encouraging messages to the evacuees, and point out that it is necessary for the whole village to think about the problem of evacuating the elderly. Examples of their messages and responses are as follows:

Evacuee: Don’t be afraid, just keep running

Students: When evacuating at night, bring a flashlight

Evacuee: Walk in a single file on narrow roads

Students: Wider roads are safer

Messages from evacuees are presented above those from students, which are presented 5 seconds later because they are responses. Total presentation times are 20 seconds for evacuee messages and 15 seconds for student messages, after which both simultaneously disappear. When all messages have been added, the multi-screen movie editing process is complete.

4.3.4 Results of the single-person drill

As yet, students of Okitsu Elementary School have participated in two times of eight residents’ single-person drills, on 26 June 2012 and 28 November 2012. A total of 13 hours of integrated study period have been used for the drill. Specifically, three hours were used for tool operation training, four hours for drill implementation, two hours for

editing messages, and four hours for presenting the multi-screen movies at Disaster Education Symposium. Eight residents participated in the single-person drill, including two couples. Because couples simultaneously participated in the drill, we produced six pieces of multi-screen movies. Approximately 35 journalists covered either the drill implementation or the movie presentations. There were also several interviews with schoolteachers about the single-person drill.

The time allocated to integrated study period is limited, so students cannot freely take part in the single-person drill. I therefore stayed in Okitsu in May 2013, October 2013, and January 2014 to independently conduct single-person drills with community residents. Only one video camera was available for these drills, so the implementation process was somewhat simplified. To differentiate between the two types of drills, I refer to the original one as the “basic single-person drill,” and the simplified one as the “simplified single-person drill.” Chapter 5 presents detailed information about the simplified drill, but here I briefly introduce it for discussion.

To date, 24 community residents have participated in the simplified drill. Results of the drills were recorded as paper records. One side of a paper record presents all categories of information shown in the multi-screen movies, such as departure place, evacuation routes, evacuation shelters, time used for the drill, help among neighbors, and messages from evacuees and supporters. The other side presents two screenshots from a computer animation of a simulated tsunami overlaid with GPS data. The paper records are used to give feedback to evacuees.

After taking part in the single-person drill, some evacuees became clearly more interested in tsunami risk reduction. For example, some participated in an annual evacuation drill conducted by Okitsu Volunteer Organizations for Disaster Prevention, or in evacuation drills for students at Okitsu Elementary School. During these drills, some participants went to different evacuation shelters to practice evacuating secondary or tertiary shelters when primary shelters are inaccessible. Most participants recorded evacuation times using their own watches.

The time needed for each single-person drill varies with factors such as evacuee health, distance to an evacuation shelter, and weather conditions. Generally speaking, the full single-person drill from step one to step four requires at least 30 minutes, and in some cases even required 4 hours. Evacuees with a high interest in participating in local events were willing to spend more time for step four. In contrast, some evacuees were unwilling to use so much time on drills, due to work demands.

4.4 Continuous improvement in tsunami risk reduction

In this section, I discuss continuous improvement to tsunami risk reduction seen in Okitsu resulting from the single-person drill and production of the multi-screen movies.

4.4.1 Development of the single-person drill

Though the single-person drill focuses on individuals, many other activities are inevitably interwoven, such as disaster education, general disaster prevention, academic studies, and journalistic activities. All of these activities and related participants are thus bound together by the single-person drill to form a larger collaborative activity. In such activities, researchers become partners collaborating with community residents through sharing active risk. Community residents also initiated taking part in reducing active risk. In this section I focus on collaborative activities, discussing the importance of forming relationships in tsunami risk reduction.

Intimate relationships among single-person drill evacuees have been confirmed. For example, some evacuees recommend neighbors as drill candidates. Other evacuees aided elderly neighbors incapable of independent evacuation. This is a mutually concerned relationship between two people who care for each other, as typically seen among family members. This relationship has been suggested as an effective means of promoting disaster prevention (Yamori 2014). Figure 4.1 gives a concrete example of a mutually concerned relationship formed in the single-person drill, from which it is easily to see a snowball effect on the increase of evacuees. Meanwhile, it indicates that the single-person drill is not an isolated activity, but one that continuously develops through evacuee contributions.

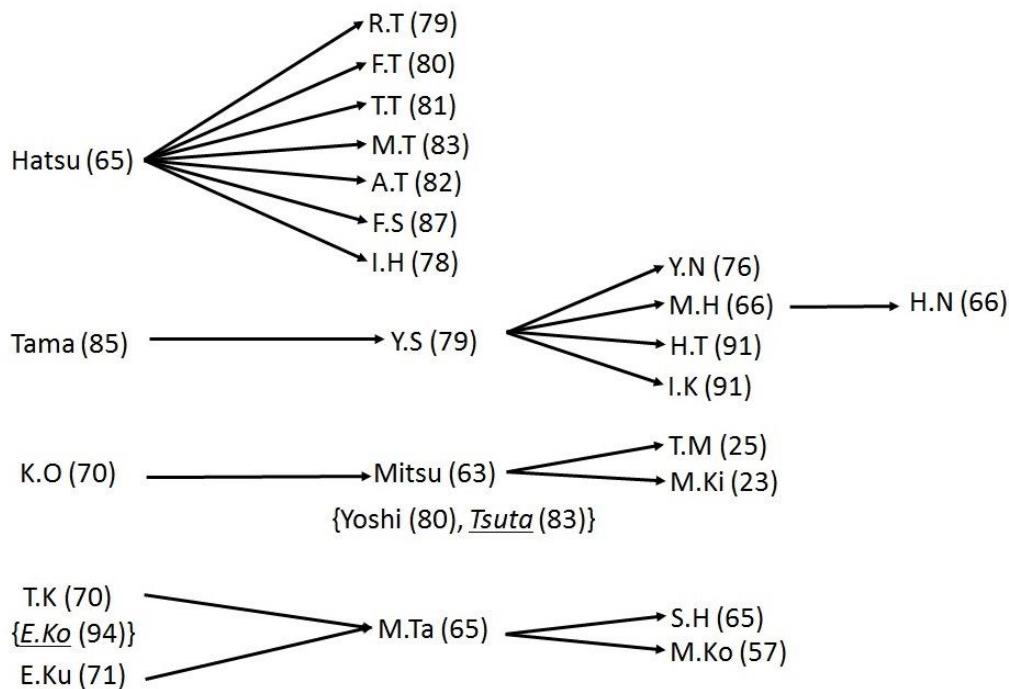


Figure 4.1 Mutually concerned relationships⁴⁻¹

News reports furthermore introduced the single-person drill to other areas, establishing a relationship between Okitsu community residents and outsiders. As an example journalists from Kahoku Shimpasha not only reported on the single-person drill in detail, but also put it into practice in a Miyagi prefecture community, where it was conducted as part of an activity aimed at promoting disaster prevention in areas affected by the Great East Japan Earthquake. During that drill grandparents and grandchildren walked together to evacuation shelters, both to check evacuation routes and to motivate risk communication between generations. To date, 27 people have participated in the drill (Sudo, Takahashi, and Higashino 2013). In addition, the Osaka Station of the Japan Broadcasting Corporation reported on a single-person drill conducted in Okitsu in a television show about disaster education (NHK 2012). Such influential news reports have helped translocate single-person drill to other local practices, thus giving rise to inter-local practices (Sugiman 2013).

The two types of relationships in the single-person drill, those among community residents and those between insiders and outsiders, are interrelated. Insider contributions to the single-person drill become resources for outsiders to develop new activities, while outsider encouragement and concern become incentives for insiders to continue the drill. This relationship can be seen clearly in the following comments given by an evacuee:

Some friends phoned me after I participated in the drill, and said, “I saw you on TV. You look so young, and so strong.”... Also, some relatives called me from Osaka. It’s so nice. I feel so good. ...When my grandchild participated in the evacuation drill for students, I climbed up to the evacuation shelter with her. My niece recorded our movements using her own camera. I think I have shortened my arrival time by several minutes ... From now on, I will go to the shelter every day just for a walk. (Tama, 85 years old, 29 January 2013)

4.4.2 Application of multi-screen movies

Students who served as supporters during the single-person drill gave presentations at Disaster Education Symposium that convenes at Okitsu Elementary School, attended by all students there, students from Okitsu Junior High School, community residents, government officers, journalists, and disaster experts. The following excerpt from one presentation is good evidence of the students’ learning outcomes:

We supported Tama in her single-person drill. Tama is 85 years old. She lives in the Urabun community. There are some dangerous places near her house, such as clay tiles on roofs that might collapse after an earthquake. There are also dilapidated houses along her evacuation routes, so it is important to consider optional routes to the nearby Saihoji evacuation shelter.

It was raining heavily on the evacuation day, so moss on the steep evacuation routes got really slippery. It is necessary to do cleaning and maintenance of the routes regularly. We also think elderly persons should be sure to have comfortable, non-slip shoes, in case they need to evacuate.

This content is included in the multi-screen movies, and when read aloud by students, it can be heard without reading the captions in the upper-right panel, which might be difficult for elderly individuals with poor eyesight. Thus the presentation helps such viewers to better understand the movies, and also enhances active risk communications between generations.

In the presentation, evacuees also actively share their experiences with other community residents. Matsu, who is 65 years old, said, “I was greatly encouraged by the students. I think I have shortened almost two minutes from the time I require to get to the evacuation shelters.” M. Kajihara, who is 80, said, “I forgot to turn off the gas in the kitchen before the evacuation.” This indicates reflection on the single-person drill process and consideration of appropriate measures during tsunami evacuation. Other residents, too, seemed highly motivated by the single-person drill. After the presentation, they immediately indicated their enthusiasm, saying they would like to participate again to help support students. This again confirms a mutually concerned relationship. After watching a computer animation of tsunami, some residents indicated better understanding of the damage a tsunami would cause, and wanted to know how long it would take a tsunami to arrive at their house.

4.5 Theoretical considerations

In this section, I make some theoretical considerations from the perspective of communities of practice regarding collaborative activities between researchers and co-researchers by discussing the significance of the single-person drill and the functions of multi-screen movies in tsunami risk reduction.

4.5.1 Significance of the single-person drill

As the single-person drill is developed by various participants and can be viewed as a collaborative activity, it would be very useful to apply the theory of communities of practice as argued in Chapter 1, and discuss its theoretical significance. Lave and Wenger (1991) reject the traditional view of learning arising out of mental operations for acquisition of knowledge, and instead locating learning in the reproduction of practice and identities of participants in communities of practice. However, I have argued that in the field of disaster prevention it is also important to consider artefacts to discuss the process and effectiveness of participant collaboration. In this section I therefore focus on the production and reproduction of artefact, practice, and identity to discuss the theoretical significance of the single-person drill.

Artefact reproduction

Objects such as computers or tables are clearly physical artefacts, but for example Halloween or Christmas can also be seen as symbolic artefacts; when they reappear frequently or repeatedly, they have similar functions as physical ones (Sugiman 2006).

This is why opposite attitudes of interest and indifference to tsunami risk reduction have emerged in Okitsu; it is a result of large-scale artefacts such as evacuation facilities,

community disaster maps, and the Integrated Disaster Prevention Committee established by the Okitsu Elementary School and the Okitsu village. These achievements contribute to overcoming issues seen during the preparation period and to promoting tsunami risk reduction during the development period. Nonetheless, they also seriously polarized attitudes during the plateau period.

In contrast, the single-person drill applied flexibly small-scale artefacts such as video cameras and GPS device to the utilization of existing large-scale ones. Single-person drills also aided production or replication of many new artefacts through the collaboration of various participants, such as the multi-screen movies and the Disaster Education Symposium. The single-person drill can thus shift comparatively large-scale artefacts from the whole community level to the personal individual level; when a resident actually climbs up to an evacuation shelter, the existential meaning of the shelter is changed in the resident's mind from that of a simple physical artefact to one of vital existence. Community residents who have never been to evacuation shelters may hold a mental image of successful tsunami evacuation being impossible, and may have given up on the idea of evacuation. Actually visiting evacuation shelters with students forces realization of the possibility of evacuation, transforming the mental image of large-scale artefacts. The drill also significantly contributes to the improvement of evacuation facilities, because the evacuation experience reveals the strength and weakness of the facilities.

Practice reproduction

Because the single-person drill specifically emphasizes the importance of actual behavior by each participant, it also functions to shift the focus of tsunami risk reduction practice from the community level to the individual level. I consider this an effective way of overcoming the polarized attitudes described above, by recasting tsunami evacuation from a general, non-urgent condition as a specific, concrete task that can be accomplished by individual residents.

The single-person drill promotes co-learning of tsunami risk reduction among intergenerational participants. The drill also combines active intervention of researchers in the community and the neutral research activity of collecting data such as evacuation behavior and facility effectiveness. Collaborative practice between researchers and co-researchers is expected to overcome problems often seen in community-based disaster prevention activities, such as insufficient collaboration between community residents and disaster experts and over-dependency on infrastructure and experts.

The single-person drill involves people and artefacts that had not previously taken part in tsunami risk reduction, and former strangers become partners in collaborative activities. As an example, producing the multi-screen movies combined evacuee behavior and academic activities to produce artefacts. The movies revealed information such as frequently used evacuation routes and places where brick walls should be removed to improve evacuations. The single-person drill thus produced or reproduced tsunami risk reduction practices and artefacts when community residents collaborated with government officers to upgrade dilapidated bridges or widen narrow evacuation routes.

Identity reproduction

Disaster prevention practices should provide an appropriate stage for collaboration between community residents and disaster experts, which can eventually reconstruct and reproduce the identities of all the participants (Yamori 2009). The single-person drill has gradually changed community attitudes regarding disaster, transforming residents' self-view as one who will need help to one of being someone who will take initiative in reducing active risk. Disaster experts and government agencies have also recast themselves as people who know risks by calculating neutral danger, to one of partners who collaborate with community residents by sharing active risk.

Regarding reproduction of identities in students and community residents, it is clear that the single-person drill provides a good chance for students to participate in tsunami risk reduction by managing the drill process as disaster education. During the drill, students take detailed notes about the whole evacuation situation from their own perspectives. After the drill, they participate in producing encouraging messages to evacuees and discussing problems and shortcomings of the overall evacuation process. This kind of disaster education provides a new approach to fostering supporters rather than mere survivors in a disaster. Students who had never taken part real disaster prevention activities, because they are usually conducted by adults, became important participants providing significant support roles, rather than token positions. The single-person drill provided them with leading roles that reproduce their identities in tsunami risk reduction.

The single-person drill easily evokes awareness of such roles, because every movement of the evacuees is recorded by video cameras. Conversely, when elderly evacuees are surrounded by young students they realize that others care for their safe evacuation, motivating them to recognize their responsibilities regarding tsunami risk reduction. These are essential meanings in tsunami risk reduction, but have largely been neglected before. For those who always had a high interest in tsunami risk reduction, verification of their behaviors using the sophisticated technology of disaster studies can motivate them to think of more appropriate countermeasures against disasters and applying them to future activities.

For example, the above-mentioned evacuee Tama, who climbed up to an evacuation shelter, said she would rather be flooded away with her house, because "it is really hard for me to evacuate." After the drill, with support from the researchers, her family members continued to encourage her, even complaining that "If you do not evacuate during a tsunami, we'll think that you don't love us." This is typical means of disaster prevention based on a mutually concerned relationship. A half year later Tama actively participated in the evacuation drill for students, climbing up to the evacuation shelter with her grandchild. According to video records taken by her family members, Tama reduced her evacuation time by almost two minutes. Furthermore, Tama declared that "From now on, I will go to the shelter every day just for a walk."

Weakness due to advanced age can reduce confidence in elderly persons like Tama, causing them to give up on countermeasures against a future tsunami. However, the

single-person drill specifically urges the elderly to play leading roles in tsunami risk reduction. This can greatly encourage the elderly, by sending messages such as “Do not surrender to a tsunami, and do not belittle its force as well,” “Do not rely on others, but think of countermeasures for yourself and your family,” and “You cannot resolve all problems at once, so try to clear obstacles one at a time.”

I now discuss reproduction of identities in disaster experts and governmental officer. These persons calculate tsunami estimates by running simulations that rely on parameters such as the earthquake epicenter, its seismic intensity, the evacuation speed, and the reception rate of evacuation warnings. These studies focus on whole communities or multiple large regions, rather than individuals. However, as discussed in Section 4.2, there are limitations on applying these studies to promoting disaster prevention awareness, and to individual activities in particular.

Researchers in the single-person drill not only take the neutral position of distributing research results to community residents, but also become collaborative partners with community residents in considering appropriate and effective countermeasures. For example, evacuating alongside community residents frequently uncovers new facts that simulations do not account for, such as unexpected walking paces among the elderly, or behaviors related to helping others. Participation in the single-person drill and careful recordkeeping thus provides researchers with valuable data related to human behavior. Disaster experts and government agencies thus reproduce their identities by collaborating with community residents and transforming their positions from thinking about only academic studies to caring about the betterment of their co-researchers.

Owing to the dynamic reproduction of artefact, practice, and identity, the negative outcomes discussed in Chapter 2, namely consolidated relationships produced by these three elements, are expected to be gradually resolved in the Okitsu village.

4.5.2 Functions of the multi-screen movies

I posed in Section 1.3.2 that this ethnographic study is an action research conducted by the collaboration of researchers and co-researchers based on the meta-theory of social constructionism. Under this research direction, the multi-screen movies are produced based on the collaboration of various participants, which provide a platform for linking and visualizing human behavior during tsunami evacuations and tsunami flooding. Owing to the collaborative efforts put into the production of the movies, two types of dialogues were achieved. One is between disaster experts and community residents, and the other is between the natural and human sciences. Here, dialogue means the dynamic transformational positions between neutral danger and active risk to promote tsunami risk reduction.

Dialogue between disaster experts and community residents

Tsunami experts and CG experts made professional contributions in editing the movies. Their responsibilities are developing sophisticated tsunami simulation models, inventing tsunami animations with high accuracy, and editing the four synchronized parts of the movies. The evacuees presented the methods, routes, and time needed for evacuation.

All of these elements are vital parameters in tsunami evacuation. The video records and student notes are also flexibly used in the editing process.

Ushiyama (2008) argues that local disaster prevention should not be restrained to just community-based activities, but must also be tested based on professional skills and developed to the level of scientific knowledge with guaranteed practice. The single-person drill is an example of the latter. Although experts did strongly influence the editing process, it would be dangerous or even damaging to the community residents without being backed up by accurate tsunami simulation calculations. The movies can be seen as artefacts that generate dialogue between actual and professional practices as conducted by disaster experts and community residents.

Dialogue between the natural and human sciences

The content shown in the multi-screen movies was produced by actual evacuee behaviors. For example, the upper-left and bottom-right panels display every movement during the evacuation. The message content shown in the upper-right panel is produced by evacuees and students during editing. At the bottom left are evacuation methods and other elements that are the results of decision-making by participants. The movie content is thus produced based on the human sciences.

In contrast, the design process of the movies is based on advanced technologies. Specifically, developing models of the tsunami simulation required applying the latest tsunami estimates given by the Cabinet Office. The worst-case scenarios shown in the movies were scientifically calculated by setting coordinate systems, epicenter, mesh sizes, and various scenarios in advance. Such preconditions allow running tsunami simulations to predict damage over time. Sophisticated technologies in the field of disaster prevention and CG production are thus merged into the movies.

A problem with current disaster prevention methods is that, while many studies have been conducted from the perspective of the social science, their methodologies are borrowed from the natural science. Such studies clearly separate researchers and research subjects, so that the former can objectively observe the latter. However, if studies of social science simply change their focus from natural phenomena to human phenomena, and consider only topics outside of natural science, social science can never keep pace with the natural science (Yamori 2009). In this sense, implementation of the single-person drill and the production of multi-screen movies can be seen as an initiative step toward tackling this problem.

4.6 Conclusion

In this chapter, I discussed collaborative activities in the single-person drill based on the theory of communities of practice. I also described the function of multi-screen movies from the perspectives of two research stances. It is necessary to know that relations between theory and practice in the human sciences are always mutually influenced. For example, through descriptions and discussions of the single-person drill by journalists or researchers, activities of tsunami risk reduction in Okitsu were immensely changed

by outsiders, from the perspective of Okitsu residents. Thus theory (e.g., tsunami estimates) is not a fixed object, but rather changed by the development of practice. Conversely, functions of practice are to verify the rationality of theory and to reconstruct it.

Finally, the single-person drill of course cannot solve all problems. While the drill emphasizes collaboration between disaster experts and community residents, on some occasions students and evacuees have been put in subordinate positions. Also, focusing on personal behaviors and considering concrete countermeasures are very effective in overcoming limitations in tsunami risk reduction, but difficulties exist in implementation processes. For example, one significant problem is that some elderly adults are incapable of independently evacuating, and it is very difficult to appoint specific people to aid their evacuation. It is furthermore difficult to discuss this issue in public. In addition, though the multi-screen movies have great influence in motivating people to participate in tsunami risk reduction, the production cost is relatively high, making it difficult to make evacuation movies for every evacuee. These problems led to modifying the single-person drill to a simplified form. Detailed information regarding this new drill is introduced in the next chapter.

Notes

⁴⁻¹ In the form of “A (60),” A is the evacuee’s name, and 60 is the evacuee’s age. All the names listed on the figure are evacuees in the single-person drill. In the form of “A→B,” B participated in the single-person drill due to the recommendation of A. For instance, Mitsu evacuated Yoshi and Tsuta during his own evacuation drill, and so do T.K and E. Ko. Note that names in the form of “C” indicate evacuees needing help but who did not actually take part in the drill. In such cases other evacuees went to evacuate them and so elapsed times were calculated during the attempt. In addition, listing the names and ages of all participants is one of the most important features of the single-person drill. Permission has been obtained from the participants for inclusion of personal information in this study.

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Chapter 5

Significance of ethnographic studies in tsunami risk reduction

5.1 Introduction

After the Great East Japan Earthquake, raising survivors became a priority in tsunami risk reduction. With this as background, the single-person drill was proposed to specifically motivate individual residents to become survivors. Rather than considering the total population of large areas, the single-person drill emphasizes the evacuation behavior of individuals and aims at elucidating concrete problems in each case. In this chapter, based on the transformation of the implementation process in the single-person drill, I describe the practical meaning of the drill in changing participant identities, and its influence on the configuration of tsunami risk reduction in Okitsu. I also offer suggestions to areas facing similar issues as Okitsu.

It is urgent that community residents of tsunami-prone coastal areas work together to overcome the difficulties of tsunami risk reduction. There are issues such as how to encourage the elderly to proactively participate in activities, and how to mitigate risk caused by the reappraised tsunami predictions. Predictions are calculated from a macroscopic perspective by external researchers, but it is important to discuss their effectiveness and limitations from a microscopic perspective, that of those who are actually involved. To better understand the actual conditions in local communities, and to suggest more appropriate countermeasures against tsunami disaster, we have to pay attention to individual attitudes and behaviors from this microscopic perspective.

In Chapters 2 and 3, I summarized historical disaster education in Okitsu from a holistic perspective, using both quantitative and qualitative data. Similarly, in Chapter 4, to alleviate negative attitudes toward tsunami risk reduction due to dire tsunami predictions, I described the implementation process and functions of the single-person drill from an overall perspective. The challenges proposed in Chapters 2 and 3, namely how to overcome polarized attitudes among residents, were thus handled by trying to reorient the direction of disaster prevention approaches from the whole community level to the individual level. It is similarly important to change the viewpoint of discussions of the single-person drill from the general to the concrete. Doing so requires a focus on minor but important cases seen during the evacuation drills. These concrete descriptions allow proposing effective methods for motivating general residents to take leading roles in tsunami risk reduction.

The remainder of this chapter is organized as follows. Section 5.2 presents the focuses of this chapter. Subsection 5.2.1 summarizes previous disaster studies based on ethnographic methods. Subsection 5.2.2 considers minor but important cases to study tsunami risk reduction. Subsection 5.2.3 presents the study objectives. Section 5.3 describes the development and transformation of the single-person drill. Subsection 5.3.1 introduces four variations of the drill. Subsection 5.3.2 talks about three types of exceptional evac-

uation cases of evacuees' identity transformation from the perspective of communities of practice. Subsection 5.3.3 discusses support for tsunami evacuation based on local needs. Finally, Section 5.4 presents conclusions of the chapter.

Chapter 6

Conclusion and recommendation

6.1 Summary of this thesis

This research is an ethnographic study in a local community, investigating problems of tsunami risk reduction posed by the Great East Japan Earthquake. It analyzed the impact of reappraised tsunami predictions for a Nankai megathrust earthquake. In this chapter, I summarize the main contents of this thesis, and further previous discussions by focusing on two points: implications of the general approaches to disaster education and tsunami evacuation (Section 6.2), and contributions to the theory of communities of practice (Section 6.3).

Chapter 1 introduced the urgent needs for countermeasures of tsunami risk reduction. In particular, it showed the importance of motivating people to immediately perform tsunami evacuation, and applying methods of both the natural and human sciences to test the effectiveness of tsunami evacuation behaviors. The chapter pointed out that one effective method of promoting disaster risk consciousness is continuing traditional approaches of disaster education, though they should aim for a balance between being a supporter and being a survivor. It then described how the research stance of this thesis is rooted in action research, which is intended to achieve a better condition for local communities through collaborative practice with local residents. To present a theoretical discussion of the process and configuration of tsunami risk reduction, it briefly introduced the theory of communities of practice.

Chapter 2 reported on disaster education conducted in the ethnographic study field of Okitsu. It focused on three periods of progress in disaster education: preparation, development, and plateau. In particular, it argued that the significant achievements of disaster education owed much to collaborative activities between residents and the community. However, those same achievements uncovered a serious problem of gaps between resident attitudes that had not been taken seriously until the occurrence of the Great East Japan Earthquake; community residents are divided into two groups, those with high concern about tsunami risk reduction and those without. Based on this situation, the chapter suggested that a thorough investigation of the problem and related countermeasures was urgently needed in the village.

Chapter 3 described the results of a questionnaire survey aimed at investigating community residents' attitudes toward tsunami evacuation. The results confirmed achievements of disaster education gained in the period of development. Meanwhile, three categories of problems—issues of individual tsunami evacuations, the impact of prediction reappraisals, and low evacuation rates—were found in the period of plateau. The chapter furthermore extended the discussion of problems related to resident attitudes toward tsunami risk reduction in Okitsu. It pointed out that a transformation of tsunami preven-

tion policy was required, specifically a shift from the holistic and abstract general level to the specific and concrete individual level.

Chapter 4 introduced a new approach to tsunami evacuation called the single-person drill, which was proposed based on the achievements and problems of disaster education in Okitsu, marking the fourth period of transformation. This chapter was mainly dedicated to describing implementation of the single-person drill, and production of multi-screen movies as its outputs. The chapter argued that, from the perspective of communities of practice, achievements of the single-person drill can be summarized into three types of reproduction: artefacts such as newly constructed evacuation facilities, practices such as intergenerational risk communication between evacuees and supporters, and transformed identities. Production of the multi-screen movies confirmed two types of dialogue, those between researchers and community residents, and those between the natural and human sciences. The chapter concluded that the essential meaning of tsunami risk reduction activities was to change neutral dangers into active risks through collaboration between researchers and community residents.

Chapter 5 furthered the discussion of the practical and theoretical significance of ethnographic studies of tsunami risk reduction by focusing on exceptional cases revealed in the single-person drill. It selected and described three types of exceptional evacuation cases—designers, campaigners, and life changers. Designers reject the methods of the single-person drill and design new methods based on their own condition or relationships with other residents. Campaigners express great interest in the single-person drill and extensively campaign for it. Life changers gradually change their attitudes and behaviors toward tsunami evacuation, and modify stereotypical images toward themselves. Based on these descriptions, the chapter suggested two methods for motivating residents to perform leading roles in tsunami risk reduction. The first was utilization and production of artefacts that initiate identity transformations in residents. The second was providing support based on local needs to urge evacuees to realize their worth of lives.

The following describes practical implications for tsunami risk reduction and theoretical contributions for the theory of communities of practice.

6.2 Practical implications for tsunami risk reduction

6.2.1 Implications for disaster education

Disaster education in Okitsu reveals two implications: the importance of balancing between being a survivor and being a supporter, and the importance of identity transformations changing passive participants into positive ones.

As mentioned in Chapter 1, one priority of disaster education is balancing the tasks of aiding supporters and raising survivors. Nonetheless, regarding lessons learned from the Great Hanshin–Awaji Earthquake, disaster education policy tends to emphasize the importance of raising supporters. Evidence included emergency rescue work conducted by private persons such as volunteers immediately following the earthquake, and the subsequent rise of disaster education programs that mostly emphasized the importance of

mutual help among communities. Chapter 1 argued that in modern Japanese society citizens have started to advocate the revitalization of mutual help since the 1980s, when rapid economic growth came to an end. Due to this background, local organizations such as neighborhood associations gradually developed resident participatory activities based on mutual help.

However, gaps emerged among areas and residents. Examples include the cases of indifferent resident attitudes toward disaster prevention described in Chapters 2 and 3, and the cases of large casualties in the Great East Japan Earthquake mentioned in Chapters 1 and 2. Under such conditions, disaster education policy had to shift, from emphasizing how to become a supporter to how to become a survivor. This movement urged disaster experts to reconsider the essential meanings of disaster education.

Differences between these two perspectives are rooted in particular anticipated behaviors during different disaster periods. The former emphasized post-disaster behaviors, while the latter emphasized behaviors during a disaster. This thesis thus proposes that disaster education policy should take both into consideration. It also emphasized that different behaviors are anticipated in different disaster periods.

For example, by examining four periods of disaster education in Okitsu, I argued that producing a new culture of disaster education was significant. As mentioned in the theoretical premises of Chapter 1, the practice of a community is reproduced as a configuration. Even for relatively narrow disaster education activities like the single-person drill, the configuration is rather complex, involving drill planners, the establishment of integrated studies, disaster experts, government agencies, managerial structures, and others. Thus, how to encourage resident identity transformation should also be a priority of disaster education.

Chapter 2 described how students took charge of disaster education activities in Okitsu, and how they performed as both supporters and survivors. Students not only regularly took part in tsunami evacuation drills to enhance their own survivability, but also made disaster maps based on community investigation to give warnings to the whole village. The achievements gained from software countermeasures were applied to infrastructure construction, which eventually benefited the survivability of the whole population. The identities of participants are concurrently changed through the reproduction of artefacts and practices. Tama, who received tsunami evacuation support from students, gradually changed her attitude and became an active participant in tsunami risk reduction. Similarly, a transformation of disaster education configurations can be seen in the single-person drill, as described in Chapters 4 and 5. Specific examples include new access to people who are not interested in tsunami risk reduction, and the support provided by residents themselves during single-person drills.

However, some outstanding issues remain. How should new artefacts and practices be applied? What are the objectives of resident's identity transformation? How can it be ensured that participants can become survivors? The next subsection discusses these issues.

6.2.2 Implications for tsunami evacuation

Tsunami evacuation activities conducted in Okitsu demonstrated that taking leading roles is essential to community residents. Chapter 1 argued that tsunami evacuation was an obvious pre-impact way of mitigating adverse outcomes by preserving lives, reducing injuries, and protecting personal property. Unlike other disaster prevention issues such as the organization of evacuation centers, tsunami evacuation must be conducted by individuals. Nonetheless, this behavior is interactive rather than individualistic (Qurantelli 1980). Under this consideration, the thesis proposed that one priority of tsunami evacuation is motivating residents to take leading roles, which includes receiving support from others when necessary. Chapter 5 proposed the importance of assisted but independent evacuees in tsunami evacuation drills, which means that some evacuees with poor health conditions could become independent by receiving help from others.

The primary method in traditional tsunami evacuation studies is development of tsunami evacuation models. Chapter 1 criticized that such studies rely on responses from those with comparatively high interest in tsunami risk reduction, or who were capable of evacuating. In this way, researchers cannot get information about those excluded from the general countermeasures and who urgently need special countermeasures against tsunami disasters. Gaps between survey results and actual behavior were usually ignored, which would mislead researchers and residents as to proper directions for disaster prevention (Sun, Nakai, Yamori, and Hatayama 2014).

Simply campaigning for evacuation behaviors proposed by disaster experts, such as avoiding the use of vehicles, cannot thoroughly change residents' attitudes and behavior. As introduced in Chapter 5, Mitsu, who was a single-person drill participant, insisted on using vehicles to evacuate based on rational consideration. In doing so, he performed a leading role in the drill. In other words, supporting autonomous behaviors and guaranteeing countermeasure reliability were important in tsunami risk reduction. The former required an identity transformation in the participant, and the latter required scientific input.

Wenger (1998) hints that forms of certain identity may be so ingrained in the practice that it may seem impossible to conceive of a different trajectory within the same community. Facilitating identity transformations in a certain community may thus require collaboration with other communities. The single-person drill provided such an example by enhancing the dialogue between disaster experts and residents. It reproduced a new community of practice based on new collaborations. When promoting resident identity transformations, the crucial factors were thus not only applying new elements to existing communities, but also reproduction of communities of practice.

Countermeasures against tsunami disaster must target saving lives, but no countermeasure can guarantee residents under stress will be survivors. As mentioned in Chapter 2, even scientifically produced hazard maps only include present knowledge, and cannot incorporate future knowledge. Chapter 4 discussed the necessity to calculate tsunami damage predictions in order to grasp neutral dangers. In contrast, Ojima's modified single-person drill, for example, demonstrated the importance to residents of transforming

neutral dangers into personal active risks, such as lead times before tsunami flooding. The production of multi-screen movies provided further examples by merging the knowledge of the natural and social sciences to produce active risks. Chapters 1 and 4 emphasized that the ultimate goal of disaster prevention was to achieve a unique consensus and to motivate communications for mutual consensus-making between experts and residents.

Achieving these purposes requires collaborative activity by experts and residents, which was presented as action research in this thesis. In the next section, I discuss theoretical contributions to communities of practice and recommend research methodologies for tsunami risk reduction.

6.3 Theoretical contributions to communities of practice

6.3.1 Action research in communities of practice

This subsection discusses three aspects of theoretical contributions, namely, that studies of communities of practice share the research stance of action research, that reproduction of artefacts in communities of practice has potential for changing the configuration of communities of practice, and that discussions of two types of identity transformations in communities of practice are important.

As introduced in Chapter 1, action research is an approach applied by the researcher, or a relationship between the researcher and the research subject. On the basis of ethnographic study, Wenger (1990:185) gave suggestions to those in the study field, stated as: “I thought it might be useful for the benefit of the people, because I believe it is the best way to be helpful given my unusual status of external observer/participant ... I would like my involvement to become more active than mere observations.” As an example, to address the problem of newcomers quitting because “training is too short and moving to the floor is too much of a shock,” Wenger suggested a “buddy system” to foster mutual responsibility by associating old-timers with newcomers.

When doing action research in the field of disaster prevention, researchers and community residents collaborate either to enhance the status quo or to reform the community configuration. They aim at achieving a better condition for the community, and in such efforts, residents make decisions regarding further improvements. Pursuing such better conditions requires participant engagement in continuous collaborative practice.

Sugiman (2006) argues that collaborative practice bringing researchers and community participants together consists of alternating movements between two modes of action. In the first mode, the present, past, and future of a field are grasped and problem-solving is initiated based on social constructionism, in the same way as logical positivism. In the second mode, the world objectified in the first mode is understood as an artefact of a particular interpretive community or tradition. This allows appreciation of the socio-historical context in which such research products and practice are generated, and consideration of their function within the broader dialogues of society.

Sawyer (2004) studied accessibility to machines of international graduate students in a science lab in Japan. She suggested that what helped students to successfully access machines was an informal network established through attending classes with other Japanese students, and participating in lab activities such as summer trips. Such students grasped machine availability within around four months, while students who disdained the summer trip required almost one year. When participants in this community of practice became aware of this issue, they moved into the second mode of inquiry.

In this study, when the basic single-person drill and the multi-screen movies were first produced all the participants were fascinated by its unique design, which merged both human behavior and tsunami movement. During the editing process that was conducted by students, however, one schoolteacher said: "It is really difficult for students to give more meaningful suggestions, because the village only has so many things." This clearly conflicts with the objective of motivating participants to perform leading roles. When we realized this deficiency, we were able to move into the second mode of the inquiry and a new method, the simplified single-person drill, was proposed. The single-person drill thus develops by alternating between the two modes of action.

Another issue I raised is that artefact reproduction in communities of practice has potential for changing the configuration of communities of practice. In Chapter 1 I argued that most situated learning studies do not provide a theoretical analysis of artefacts. Studies of communities of practice such as Wenger (1990) and Sawyer (2004) mainly focused on understanding and accessibility to artefacts, but ignore their reproduction process. They thus emphasize discussion of existing artefacts other than the dynamic productive process of outputs through collaborative activities between researchers and researcher subjects.

However, this thesis discovered and produced many artefacts contributing to the development of collaborative activities. The production of multi-screen movies enhanced resident disaster risk consciousness by transforming the holistic information of tsunami predictions into individual information. Meanwhile, as mentioned in Chapter 2, one of the most prominent features of artefacts in the field of tsunami risk reduction is that they have to be tested by scientific knowledge to avoid poor results. Not only is the production process important, but also utilization in continuous collaborative activities. For example, by applying produced artefacts to the practice, participants can better access to others who might have low interest in disaster prevention.

Finally, participants' identity transformation in tsunami risk reduction requires analytical consideration from two perspectives. One is that of previous studies of communities of practice, which focused on investigating participant access to resources such as regulations, rules, or apparatuses. In those studies, participants have already attained legitimacy for access to the practice. The other perspective is discussing identity transformations in people who did not belong to the community of practice at first, but gradually had been recognized as a member later on. Membership in a community of practice requires recognition by both the self and others. In the field of disaster prevention, legitimacy of access to disaster prevention activities is endowed to everyone. Thus, the

priority becomes one of promoting community membership, which requires modifying negative attitudes toward disaster prevention.

6.3.2 Recommendation on research methodologies

I close with some recommendations regarding research methodologies for tsunami risk reduction. Chapter 5 argued that unlike obvious problems revealed in the post-disaster period, risks in the pre-disaster period only exist potentially or vaguely, which impedes applying ethnographic approaches to disaster prevention in the long term. This is one of the main causes hindering collaborative practice between researchers and researcher subjects. However, when disaster predictions are published and gradually become artefacts, stages for conducting ethnographic studies will be provided.

The recommendation on research methodologies is therefore to apply ethnographic approaches to pre-disaster prevention. Regarding tsunami predictions for a Nankai megathrust earthquake, this thesis is completed by doing ethnographic studies in a small coastal community. It elucidated the process and the whole configuration of tsunami risk reduction. Collaborative activity in disaster prevention has unique characteristics, different from other fields. For example, researchers are required providing professional knowledge, while residents are required making active participation. In this thesis, Chapters 4 and 5 presented methodologies for collaborative practice with community residents to discuss the essential meanings of tsunami risk reduction. By doing this, it revealed two types of dialogue: those between disaster experts and residents, and those between the natural and social sciences. Such collaborative efforts become a source of power for continuing ethnographic studies.

Furthermore, while whole phenomena are usually understood by focusing on average cases, such understandings are confined in a vague and somewhat abstract sense. However, ethnographic studies allow access to minor but important concrete cases. Also, accumulating seemingly trivial comments and narratives allow researchers to make analytical discussions from the perspective of engaged participants. As described in Chapter 5, introducing exceptional cases is helpful toward obtaining a concrete and deeper understanding of tsunami evacuation. Meanwhile, promoting tsunami risk reduction in communities with an aging population like Okitsu requires personal approaches, such as understanding of the specific conditions of individual residents.

During my ethnographic studies, I found that strong linkages between school disaster education and community disaster prevention have functions to raise supporters and aid survivors. For instance, in different variations of the single-person drills, students and residents performed roles of both supporters and survivors. Meanwhile, owing to students' participation, residents' identity transformation was dramatically stimulated. Also, it is necessary to propagate tsunami risk reduction practice with local organizations. Implementation of the single-person drills received great support from the Integrated Disaster Education Committee in Okitsu. Without its legitimate recognition, the drills would be impossible. At the same time, apply new tsunami risk reduction methods to local events could have function to motivate more participation.

Several tasks regarding tsunami risk reduction remain necessary. Firstly, it is necessary to consider how to select appropriate research subjects from dynamically changing conditions in ethnographic studies. For example, if researcher puts focus on interactions between students and residents, it is helpful to making discussion from the perspective of risk communication, one of the traditional approaches to disaster prevention.

Secondly, it is necessary to consider the function of researchers participating in collaborative disaster prevention practices. For example, in the single-person drill experts from different disciplines made significant contributions by inputting their professional knowledge. Discussing this topic would be very useful for understanding the essential meanings of collaboration between experts and residents.

Finally, another necessity is considering the functions of journalists who introduce disaster prevention activities of one field to others. As mentioned in Chapters 4 and 5, many reports of the single-person drill encouraged participants and introduced the drill to other communities. Discussing this topic from the stance of journalists and residents will generate the essential meanings of disaster reports during non-emergent conditions.

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